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Joint Research Centre - Ispra Establishment
21020 Ispra (Va) - Italy

EURASEP PROJECT

OCS EXPERIMENT 1977

Report No. 1

DATA ACQUISITION

B. Møller Sørensen

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2.1.2

1/7

CONTENTS

LIST OF FIGURES

LIST OF TABLES

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1. BACKGROUND

1.1. NIMBUS-G/CZCS/NET

The National Aeronautics and Space Administration (NASA) of the U.S.A. is launching the NIMBUS-G satellite in fall 1978. This spacecraft will enter into a polar orbit with 8 sensor systems which are designed to record features on the Earth's surface and in the atmosphere.

One of these sensors is the Coastal Zone Colour Scanner (CZCS) which will be dedicated to obtain information on the quality of marine coastal waters.

A group of experts, headed by Dr. W. Hovis, NOAA/NESS forms the NIMBUS-G Experimental Team (NET). Its task is to define the problems associated with ocean color monitoring from space, work on solutions to these problems, and to establish algorithms that can be used to determine chlorophyll, turbidity and yellow substances qualitatively and quantitatively from the CZCS data.

1.2. EURASEP Project

The Joint Research Centre (JRC) of the European Communities (EC), has accepted an invitation to participate in the satellite experiment (post-launch); and to contribute to the establishment of the many definitions necessary for a successful programme through a number of prelaunch experiments.

This European project was called EURASEP, an abbreviation for European Association of Scientists for Experiments on Pollution. The project is being coordinated from the JRC-Ispra Establishment in cooperation with a large number of universities and research institutes within the European Communities.

The organizational structure of the EURASEP project is build around a steering committee with a principal investigator and government representatives from the participating countries. The scientific core in this structure comprises five working groups, as follows:

A Data Handling
B Signatures, Models, Algorithms and Atmospheric Measurements
C Flight Management and Sensors
D Sea Truth Measurements
E Oceanologic Models

Their tasks are:

- to discuss the scientific problems and produce scientific definitions adaptable to EURASEP,
- to plan and coordinate common actions in the field and in the laboratories,
- to develop theoretical models,
- to assure optimal treatment of data for the benefit of all participating countries and
- to assure the best possible communication on the common actions.

All groups have met several times since they were established in September 1976.

1.3. Pre-launch activities

As a NET member the JRC is active in preparing for the post-launch phase. This is done by participating in the NET meetings and by performing a number of pre-launch experiments. So far, these experiments have dealt with problems on:

- mesoscale atmospheric variations,
- development of a device for continuous measurements of oceanographic parameters,
- determination of radiation quantities needed for correction of CZCS data with emphasis on the advection problem of aerosols of different origin and its effects on the observations from space.

The major European pre-launch contribution, however, is the OCS Experiment '77*.

2. THE OCEAN COLOR SCANNER

The Ocean Color Scanner is a scanning radiometer build by NASA for detection and recording of upwelling sunlight from the ocean water and suspended particulate matter. It records in 10 narrow wavelength bands on magnetic tape (Appendix I).

3. PREPARATION OF THE OCS CAMPAIGN

Because of the unique characteristics of the Ocean Color Scanner, it was decided at the JRC, Ispra, to apply for a loan of the instrument to be flown at high altitude over a European test site.

The objectives of this measurement campaign was to:

- contribute to NASA's pre-launch program that primarily aims at the establishment of an algorithm through which chlorophyll-α, suspended sediments and yellow substances can be quantitatively

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* Ocean Color Scanner Experiment 1977

determined (the three primary parameters),

- offer European scientists an opportunity to work on data similar to the data from the CZCS,
- experiment in waters where the three primary parameters would be found in steep gradients and in a variety of quantity ratios,
- experiment with "real" sea truth, that is, simultaneous air and sea data acquisition with a possibility of subsequent data correlation, accurate within the order of a few pixels,
- intercalibrate as many of the European instruments, that will be used for the post-launch experiment, as possible.

NASA approved the loan of the Ocean Color Scanner to the Joint Research Centre in December 1976.

The plans for the experiment were approved at a steering committee meeting in February 1977. The approval included the selection of a test site from Noordwijk aan Zee in the Netherlands to Cap Gris Nez in France (Figure 1). At that meeting the author was appointed as a scientific test site coordinator.

Initially three test sites were considered for the experiment:

1) The German Bight with the Elb Estuary,
2) The French Atlantic coast at Brittany and
3) the Southern part of the North Sea along the Dutch Belgian and French coast.

All three sites had a high probability of ppor weather conditions with clould dover and fairly strong winds.
The latter site was chosen because:

- the three primary parameters existed in appropriate concentration and gradients,
- two major rivers, the Rhine and the Schelde, have outlets into the test sites offering a variety of mixing zones,

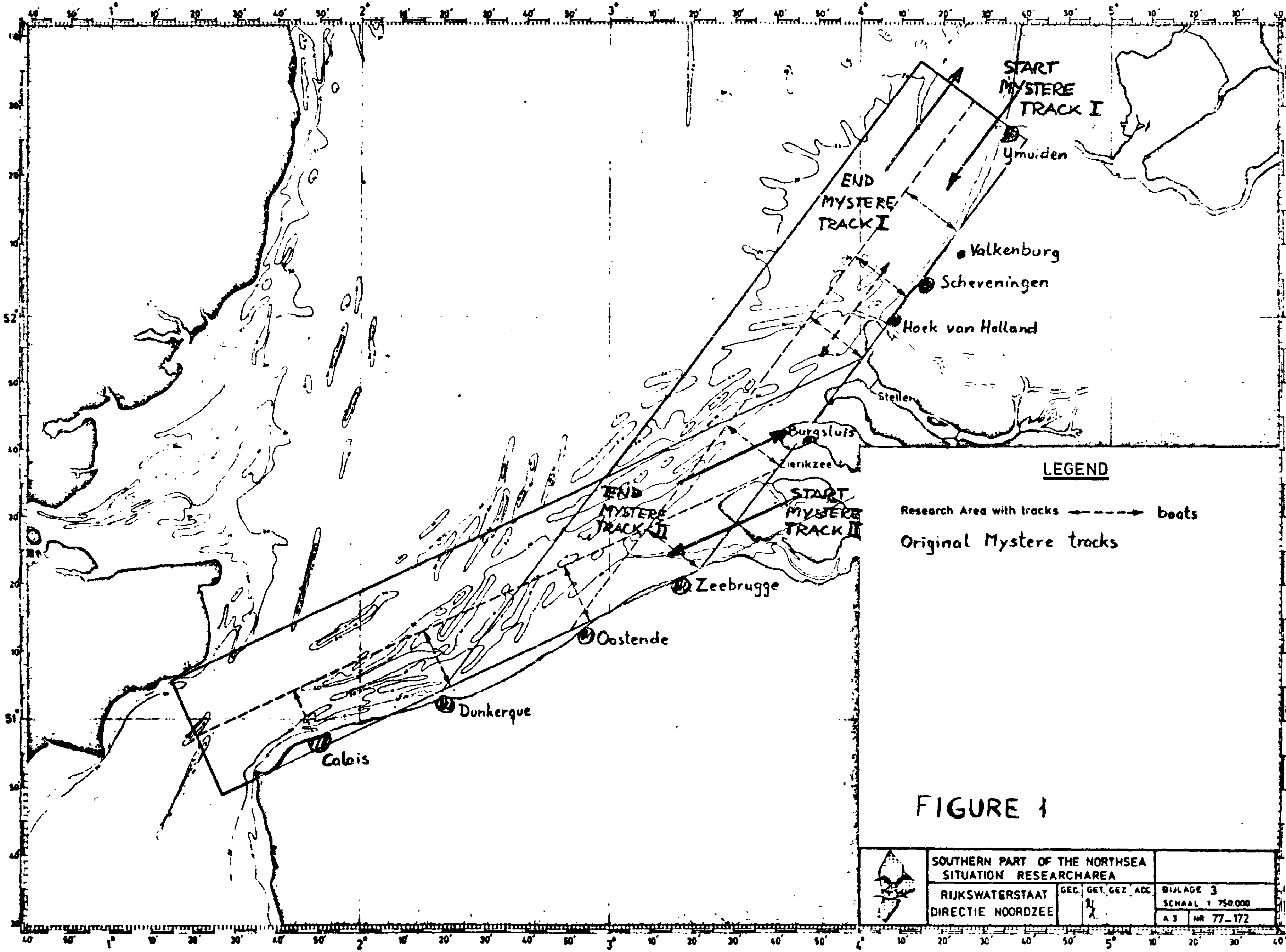
START
MYSTERE
TRACK I
Ymuiden
END
MYSTERE
TRACK I
Valkenburg
Scheveningen
Hoek van Holland
Stellen
Burgsluis
Zierikzee
START
MYSTERE
TRACK II
END
MYSTERE
TRACK II
Zeebrugge
Oostende
Dunkerque
Calais
LEGEND
Research Area with tracks
beats
Original Mystere tracks
SOUTHERN PART OF THE NORTHSEA
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FIGURE 1

- a varied coast and bathymetry existed in the area,
- this coast line could be divided into two flight tracks that would make good flight planning feasible,
- this coast line has a relatively large number of ports, providing a good base for the participating vessels,
- the existing communication facilities, navigation aid and maps of the area were excellent.

A hydrodynamic model based on data previously collected in this area, could be made and tested. Using such a model to correct sample stations along the ship tracks for tidal current would enable the analysts to simulate a real time correlation of sea truth data with flight data. On the other hand, much of the data acquired during the experiment could be used to further test the model.

From early March 1977, the preparatorywork made by the EURASEP working groups entered a more detailed phase of campaign coordination and instrument preparation. A PCM coder (digitizer) was specially build by a private company on order from JRC, Ispra. Various types of equipment for conventional oceanographic measurements were designed and build. Finally, a communication and control center were established in a Rijks-waterstaat building at Rijswijk in the Netherlands.

By June 10, 1977 the project was ready for a one week pre-stand-by programme.

4. PRE-STAND-BY ACTIVITIES, JUNE 13 - 19, 1977

Some important actions took place during the last week before the 2-week stand-by from June 20 to July 3. More than 100 scientists and technicians had to be briefed, and the instruments intercalibrated and installed. Finally a test run with all participants was conducted from the control centre in the Netherlands to assure that all equipment and the communication functioned well.

4.1. Installation of the Ocean Color Scanner

The OCS was installed in a Mystere 20 Falcon Jet aircraft at Creil airfield north of Paris, France, from June 15 to 17. Instrument specifications and other technical data are given in four working papers in Appendix I. A specialist from NASA assisted on the installation.

4.2. Intercalibration of Sea Truth Instruments

A large part of the oceanographic instruments on the market today was represented at the IZWO* Laboratories, Ostend, Belgium, where an intercalibration took place on June 15.

Water was collected early in the morning from two positions off the Belgian coast where chlorophyll content and turbidity were known to be distinctly different. All instruments placed around a large water tank measured first on water from one position, then from the other, and finally on a mixture of the two samples. The parameters measured were chlorophyll, turbidity, salinity and temperature, that is, the four parameters which were to be measured continuously on board the vessels simultaneous with the overflight. The samples were analyzed by conventional laboratory methods on the day of the intercalibration in order to have absolute values. Some of the problems encountered during the exercise are described in Chapter 8.1.

4.3. Information Meeting with Sea Truth Teams

A "teach-in" with all sea truth teams was held on June 14, in Ostend, Belgium. The campaign was described in detail and each team leader received the forms, instruction sheets, positions and time tables necessary

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* Institute for Marine Scientific Research

to operate within the very tight schedule set up for the experiment. Also information and demonstrations were given on the use of optical filters and Dr. Austins Munsell Color Panel* together with the Secchi disc.

4.4. Information Meeting with Atmospheric Measurement Teams

Following a Working Group B meeting on June 7, where the atmospheric measurements in connection with the OCS experiment were defined, a team leader meeting was held in the Hague, the Netherlands, with the campaign coordinator on June 19. The final details concerning facilities at measurement stations were given and communication procedures were established. Transportation of teams to the off-shore platforms by helicopter was arranged, so that all teams were ready to measure on June 20.

4.5. Test flights and Sea Truth "Dummy Runs"

Two test flight with the OCS on June 18 ensured proper function of the electronic circuit from OCS via oscilloscope, time coder, roll correction unit, degitizer to tape recorder.

Also on June 18 a "dummy run" with all nine vessels was made to test the timing, communication and sea truth equipment. Adjustments and corrections of malfunctions experienced on that run were made on June 19.

5. OCS SUPPORT FROM A MULTISPECTRAL SCANNER ON A MEDIUM ALTITUDE AIRCRAFT

A German owned Dornier 28 Skyservant aircraft was included in the project as a supporting data acquisition platform. It carried the following instruments:

* From Scripps Institution of Oceanography, Visibility Laboratory, San Diego, U.S.A.

11-channel Bendix scanner

PRT-5 Barnes radiometer

Zeiss metric camera (color film for ship identification)

Exotech LANDSAT compatible radiometer (pointing up)

Hasselblad camera (color IR film).

The OCS is a prototype instrument and no scanner with a similar unique Signal/Noise (S/N) ratio (see Table 1) could be used as a back-up system in case of a failure in the OCS system. In addition, the French owned Mystere was at that time the only European aircraft with an appropriate window in the fuselage that could fly at 11000 meters. Thus, it was well understood that the value of the experiment would be drastically reduced in case of malfunction of the OCS system. Including the **Dornier** aircraft with a conventional multispectral scanner to fly at medium altitude increased the probability of obtaining aerial data in any event. It also added an aerial thermal infrared imaging sensor to the experiment. Although calculations show that the Bendix M^2S is far from ideal for oceanographic remote sensing, it was the only available multispectral scanner offered to the project at a low cost for the stand-by period.

The use of a thermal infrared imaging sensor in the project was expected to give the following advantages:

- a record of any upwelling that might occur along the coast of the test site,
- a delineation of the mixing zones around estuaries,
- an indication of currents near the coast line by following discharges from smaller outlets.

6. PROJECT PLAN

The major drawback of the test site is its geographical position with a potential for long periods of poor weather conditions for remote sensing data

	OCS				M^2S					DAEDALUS 1260				
FOV (total)	90°				100°					90°				
IFOV	3.5 mr				2.5 mr					2.5 mr				
	λ_c nm	$\Delta\lambda$ nm	S/N rms	NE$\Delta\rho$ %	λ_c nm	$\Delta\lambda$ nm	S/N rms	NE$\Delta\rho$ %	NE ΔT °C	λ_c nm	$\Delta\lambda$ nm	S/N rms	NE$\Delta\rho$ %	NE ΔT °C
Channel 1	431	24.2	582	0.172	410	60	14.0	$\leqslant 2.0$		400	40	not available at the time of writing	< 5.0	
Channel 2	472	26.0	949	0.105	465	50	67.6	$\leqslant 0.5$		435	30		< 1.5	
Channel 3	506	25.0	876	0.110	515	50	156.4	$\leqslant 0.3$		475	50		< 0.5	
Channel 4	548	26.3	910	0.110	560	40	176.3	$\leqslant 0.3$		525	50		< 0.3	
Channel 5	586	24.1	582	0.170	600	40	153.6	$\leqslant 0.3$		575	50		< 0.2	
Channel 6	625	25.3	525	0.190	640	40	215.0	$\leqslant 0.3$		625	50		< 0.2	
Channel 7	667	24.2	525	0.190	680	40	234.7	$\leqslant 0.4$		670	40		< 0.2	
Channel 8	707	26.0	351	0.285	720	45	185.8	$\leqslant 0.5$		745	90		< 0.3	
Channel 9	738	24.0	351	0.290	815	90	223.1	$\leqslant 0.5$		845	90		< 0.5	
Channel 10	778	26.1	351	0.285	1015	90	151.8	$\leqslant 1.0$		965	90		< 1.0	
					μm					μm				
Channel 11					8 - 12		62.5		$\leqslant 0.25$	8.5 - 14				< 0.2

TABLE 1

acquisition. Therefore the project plan included a stand-by period for all equipment and participants of up to two weeks, starting onJune 20, 1977.

The following describes the many functions necessary for a successful experiment.

6.1. Weather Forecasting

The satellite tracking station at the University of Dundee, U.K. recorded NOAA-5 signals every day at 9 a.m. and combined it with Bracknell meteorological station, U.K. A cloud cover forecast should be telexed and telephoned to Holland at 10 a.m. each day during the stand-by period from that station. If a "clear" signal was given, all vessels would be directed to their starting positions where they should wait for a "go ahead" call from the communication center. This "go ahead" message would be based on a second "clear" signal from a new cloud cover forecast at noon. At the noon "clear" signal, the aircrafts would also be given a "go ahead" signal.

The OCS experiment should work in GMT.

Weather forecasting on a 24, 48, 72 hour basis should also be given each day during the stand-by period by Institut Royal Meteorologique de Belgique (Sneyers). This institute and Valkenburg airfield should provide information daily about wind direction/velocity at 11.000 m altitude over the test site.

6.2. Communication Center

A communication center, called "EURASEP CONTROL", should be set up in the main building of the North Sea Directorate, Rijkswaterstaat in Rijswijk, the Netherlands. The entire OCS experiment should be directed from this center.

Ground-Aircraft Communication

For the communication between aircrafts and ground VHF channel 130.1 MHz had been reserved for the OCS experiment. A radio set had been provided by National Lucht and Ruimtevaart Laboratorium (NLR). The range of this equipment is 380 km to an aircraft at 11.000 m altitude and 225 km to an aircraft at 4000 m altitude.

Ground-Boat-Communication

Vessels should communicate with EURASEP CONTROL on Middle wave (MW) on duplex 2.391 MHz via the vessel "Smalagt". All vessels had VHF channel 6 (156.3 MHz) and 8 (156.4 MHz) on board as a reserve.

"Smalagt" should communicate with EURASEP CONTROL on VHF and act as a communication link between the control center and all vessels.

All radio communication would be in English because it is spoken by most participants. There should, however, be persons in the communications center who spoke all the major languages of the EC.

EURASEP CONTROL was furnished with map boards, black boards, eight telephones and there was access to a telex.

6.3. Aircrafts and Sensors

The French Mystere 20 Falcon Jet and the German Dornier 28 "Skyservant" aircrafts should arrive at the Dutch military airfield Valkenburg in the afternoon on June 19. This airfield should be their base until the campaign was completed. Start and end positions for recording would be given to the flight crew during a preflight briefing. The track of Leg 1 is 217° and 37° for both aircrafts. The track of Leg 2 is 246 and 66° for both aircrafts.

A Cessna 402 aircraft stationed at the Amsterdam Schiphol airport should be used for ship identification and positioning.

The French organization, Groupement pour le Développement de la Télédetection Aerospatiale (GDTA), made a B-17 aircraft available to fly over the French coastal areas from the Belgian border to the town of Dieppe. Ideally, it should take off from Creil airfield north of Paris (F) and fly simultaneous with the Mystere. Therefore, the same two week stand-by period was scheduled. The details are given in Appendix II.

6.3.1. Mystere 20 Falcon Jet

The Mystere should fly at 11.000 meters altitude at 200 m/s $\sim$720 km/h. The effective swath angle of the OCS is 80^{o} giving a ground swath width of 18.500 m. The spatial resolution at nadir would be 38.5 m.

As some of the ships used for the experiment would be smaller than one OCS pixel, it was decided also to carry a camera for identification of the sea truth vessels. A Fairchild K24 camera charged with Kodak Ektachrome MS Aerographic 2448 film was used for this purpose.

FLIGHT SCHEDULES

Mystere 20:

Start Valkenburg	1240 hours	
Start Leg 1 NE-SW	1300 "	Start recording
End Leg 1 NE-SW	1312-1315 hours	Stop recording
Start turn to Leg 1 SW-NE	1312-1315 "	
Start Leg 1 SW-NE	1317-1320 "	Start recording
End Leg 1 SW-NE	1332-1335 "	Stop recording
Arrival at Valkenburg	1345 hours	
Change of HDDT 20 minutes		
Start Valkenburg	1405 hours	

(continued)

Start Leg 2 NE-SW	1430 hours	Start recording
End Leg 2 NE-SW	1440-1444 hours	Stop recording
Start turn to Leg 2 SW-NE	1440-1444 "	
Start Leg 2 SW-NE	1445-1449 hours	Start recording
End Leg 2 SW-NE	1500-1504 hours	Stop recording
Arrival at Valkenburg	1520 hours	

This flight schedule would assure a maximum deviation from the sun angle of $\pm$ 5-6^{o} during the flights in both directions within the period June 20 to July 3.

The Ocean Color Scanner recording should commence approximately 10 km North of the platform "Noordwijk" from NE to SW on Leg 1 and at position 51^{o} 03' N-2^{o} 38' E on Leg 1 from SW to NE.

On Leg 2 recording should start at position 51^{o} 30' N - 3^{o} 33' E and continue until the aircraft had past Cap Gris Nez in NE-SW direction. In the SW-NE direction on Leg 2, recording would start at position 51^{o} 03' N - 1^{o} 23' and end at position 51^{o} 50' N - 4^{o} 06' E.

The total estimated recording was in the order of one hour.

6.3.2. Dernier 28 "Skyservant"

The Dornier should fly at 4.000 meters altitude at 70 m/s $\sim$250 km/h. At that altitude, the effective swath width is approximately 9.000 meters. Unlike the OCS, the Bendix scanner has a thermal infrared channel and would therefore provide a very important additional source of information. The thermal imagery combined with a nadir profile from the PRT-5 Barnes thermal IR radiometer are recordings of the temperature of the water "skin" surface. This data should be correlated with the temperature measurements made from the vessels.

The LANDSAT compatible radiometer (Exotech model 100) pointing up would measure the incoming radiance in the four LANDSAT MSS bands. The Zeiss metric camera charged with Kodak Ektachrome MS Aerographic 2448 film was included for ship identification like the camera on board the Mystere.

FLIGHT SCHEDULES

Dornier 28

Start Valkenburg	1150 hours	
Start Leg 1 NE-SW	1200 hours	Start recording
End Leg 1 NE-SW	1236 hours	Stop recording
Start turn to Leg 1 SW-NE	1236 hours	
Start Leg 1 SW-NE	1244 hours	Start recording
End Leg 1 SW-NE	1324 hours	Stop recording
Arrival at Valkenburg	1332 hours	
Start Valkenburg	1347 hours	
Start Leg 2, NE-SW	1411 hours	Start recording
End Leg 2 NE-SW	1451 hours	Stop recording
Start turn to Leg 2 SW-NE	1451 hours	
Start Leg 2 SW-NE	1459 hours	Start recording
End Leg 2 SW-NE	1549 hours	Stop recording
Arrival at Valkenburg	1614 hours	

Total estimated recording time: 2 hours 26 minutes.

This flight schedule would assure a maximum deviation from the sun angle of less than 30° during the flights in both directions within the period from June 20 to July 3.

6.3.3. Cessna 402

The Southern Bight of the North Sea is one of the areas with the heaviest oil tanker traffic in the world. This could be an obstacle for the OCS experiment ship tracks going perpendicular to the main flow of the traffic, but the experiment could also benefit from the presence of big tankers.

The outer flight tracks would be over open sea. Therefore, no land would appear on the images, causing difficulties with the exact location of features observed on the images.

During the flights of the Mystere and Dornier, a Cessna 402 with 6 VHF radios, provided by the Rijkswaterstaat, the Netherlands, should fly over the test site at low altitude. The pilot should select large tankers one by one, fly low enough to read the name of the ship and then call it to ask for its exact position. In cases where tankers would be at anchor, the position should only be asked once. For moving ships it would be necessary to have the positions at frequent time intervals during the Mystere and Dornier overflights.

6.4. Sea Truth

Nine vessels had been assigned to the experiment for sea truth data collection. Their ports and tracks are indicated on Fig. 2 which also shows the Noordwijk stationary platform where sea truth measurements should be made as well.

All vessels should navigate by means of Decca. Besides the crew, each vessel should carry at least one scientific team of no less than three persons. The team leaders would be responsible for the acquisition and storing of data as well as for recording sampling positions.

Each vessel should make continuous measurements of chlorophyll, turbidity, salinity and temperature. This would be accomplished by using a floating water intake and instrument arrangement designed by Dr. Charlton* as shown on Figs. 2 and 3. Approximately 20 near-surface samples should be taken at equal distance along the track for a calibration of the continuous measurements.

At the half way point of the track, each vessel should stop and make profile sampling to a depth of at least 2.5 x Secchi Disc depth. This would be performed simultaneously with the Mystere overflight. The water samples should be filtered immediately on board and frozen.

Secchi disc (SD) measurements would be made at the start position, vertical sampling station and the end position of the track. Subsequent to the SD measurements, the Munsell Color Code** should be determined according to the instructions in sheet 10^a, Appendix III.

The SD extinction depth seen through the optical filters, Wratten 98, 99 and 29 (blue, green and red)*** should be measured at the stations where the Munsell color of the water would be determined. Instructions for the use of optical filters are found on sheet 10^a, Appendix III.

All instruction sheets, forms, etc., given to the team leaders before the experiment for use at vessels, are included in Appendix III.

Start and end positions for the nine vessels are given in Table 2.

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* Chairman of the EURASEP Working Group "Sea Truth Measurements"

** Using a panel designed by Dr. Austin, Scripps Institution of Oceanography, San Diego, California, U.S.A. The panel contains color chips coded by Munsell and corresponding to the water colors normally encountered in coastal and open sea marine waters.

*** These measurements were suggested by Dr. Dörfer, Univ. of Hamburg, Germany.

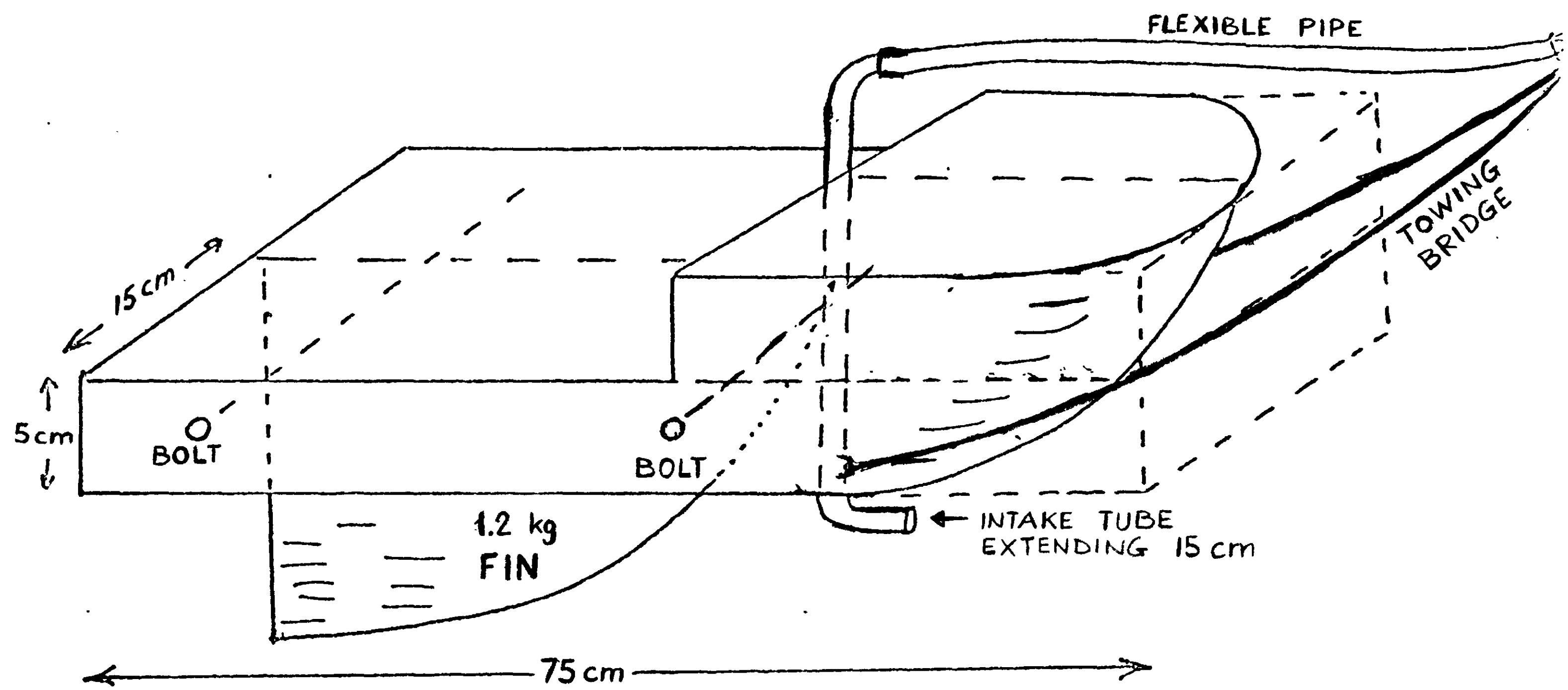


FIGURE 2. J.A. CHARLTON'S FLOATING INTAKE

J.A.CHARLTON : SCHEME FOR ON-BOARD CONTINUOUS SURFACE SAMPLING

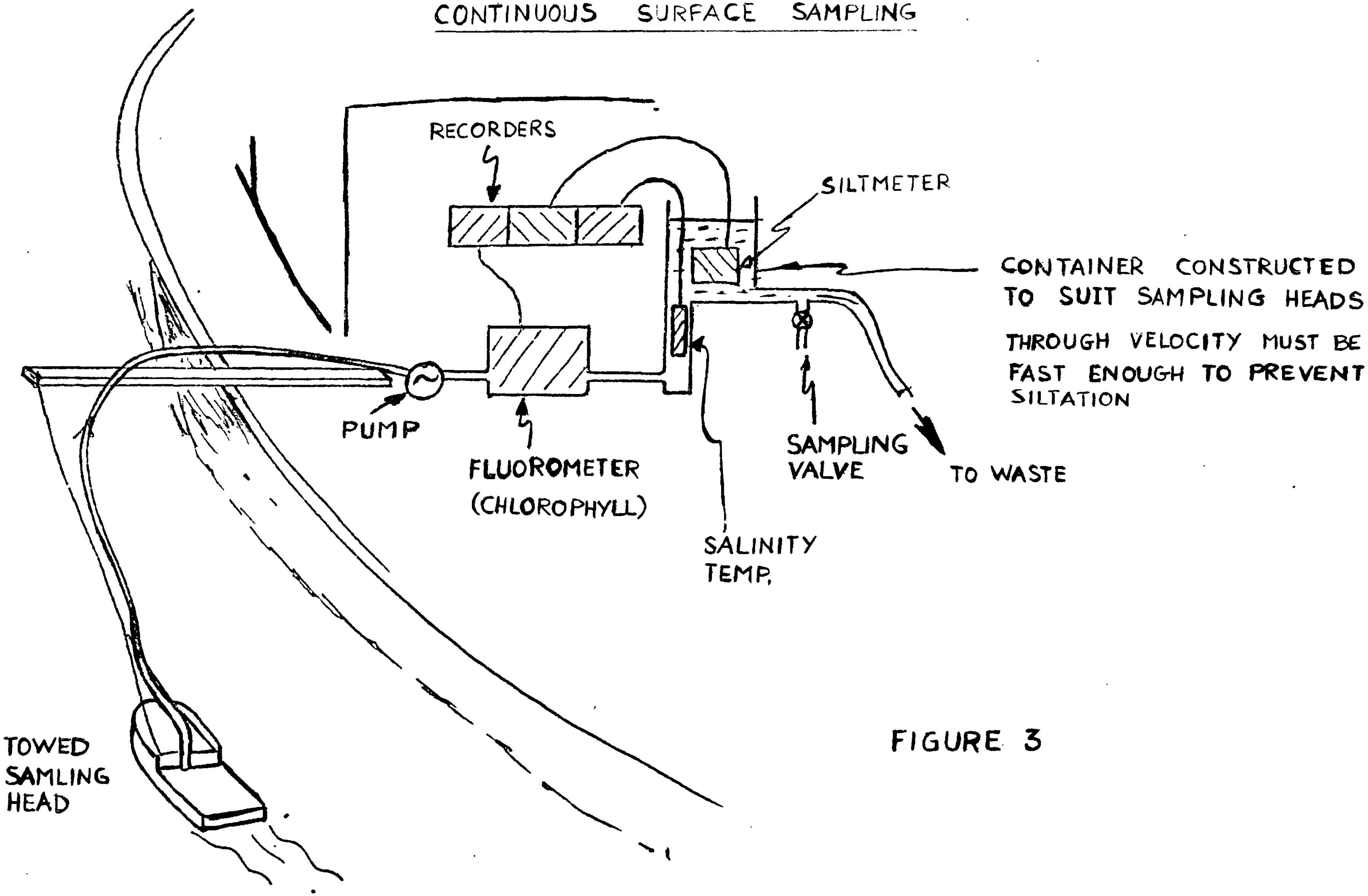


FIGURE 3

TABLE 2

	Vessel	Start position	End position	Decca Line
1.	"St. Eloi" from Calais	50° 57.5′ N - 1° 43.1′ E	51° 10.5′ N - 1° 32.3′ E	E-13
2.	"Père Duval" from Dunkerque	51° 02.7′ N - 2° 11.7′ E	51° 10.0′ N - 2° 02.7′ E	F-14
3.	"Asselt" from Oostende	51° 15.1′ N - 2° 55.6′ E	51° 21.2′ N - 2° 42.8′ E	H-2
4.	"Mechelen" from Zeebrugge	51° 21.4′ N - 3° 16.5′ E	51° 27.4′ N - 3° 00.7′ E	H-16
5.	"Zander" from Dundee	51° 39.7′ N - 3° 38.8′ E	51° 49.5′ N - 3° 28.0′ E	G-30
6.	"Octans" from Hoek van Holland	51° 59.4′ N - 4° 05.3′ E	52° 09.3′ N - 3° 58.9′ E	D-39
7.	"Smalagt" from Scheveningen	52° 02.8′ N - 4° 10.1′ E	52° 11.1′ N - 3° 59.5′ E	
8.	"IJmond" from IJmuiden	52° 15.4′ N - 4° 25.2′ E	52° 20.6′ N - 4° 10.5′ E	
9.	"Christiaan Brunings" from Hoek van Holland	52° 10′ N - 4° 11′ E	51° 54′ N - 3° 52′ E	

From the Noordwijk off-shore platform at position 52°16'25,9" N - 4°17'54.8" E at least the following measurements wereplanned:

- turbidity at 1 meter and 5 meters depths
- water temperature at 1 meter and 5 meters depth
- conductivity (salinity)
- wave height and tidal movement
- current near sea bed.

A waverider 20 kilometres west of the platform would record wave height. All data from the platform and the waverider would be transmitted to the receiving terminal of Rijkswaterstaat, Rijswijk by VHF every 10 minutes during the stand-by period.

An appropriate number of water samples should be collected underneath the spectrometer mirror on the Noordwijk platform as sea truth for that instrument.

6.5. Atmospheric Measurements

Atmospheric measurements should be performed at the following locations:

a) on the beach at Cap Gris Nez (F) (staff and equipment from the University of Lille, France)
b) on the formost western beach of the Dutch island Schouwen (staff and mobile unit with electronic equipment from the Joint Research Center, Ispra)
c) on the beach at Noordwijk (NL) (staff and equipment from DFVLR, Germany)
d) on the platform Noordwijk (NL) (staff from ZGF, Munich, Germany and Meetkundige Dienst, Delft, Holland)
e) on the Goeree light island (NL) (staff and equipment from DFVLR, Germany).

The positions of these stations are shown on Fig. 4.

The available instruments were the following:

Cap Gris Nez (Univ. of Lille):

1 Exotech model 100 radiometer

1 Polarimeter

1 Pyrheliometer

Schouwen (JRC, Ispra):

2 Exotech model 100 radiometers

1 Single lens LANDSAT compatible radiometer

1 EG and G spectroradiometer

1 Pyrheliometer

1 Heiman KT 4 Thermal IR radiometer

1 PRT-5 Barnes Thermal IR radiometer

Beach at Noordwijk (DFVLR):

3 Exotech model 100 radiometers

1 Barnes spectral radiometer

1 ISCO spectral radiometer

2 Eppley pyrheliometers

2 Eppley pyranometers

2 Thermal IR radiometers

Some of these instruments would be used on the Goeree light island.

Platform Noordwijk (ZGF, Munich):

3 Exotech model 100 radiometers

1 ISCO spectral radiometer

2 Thermohydrographs

2 Thermal IR radiometers

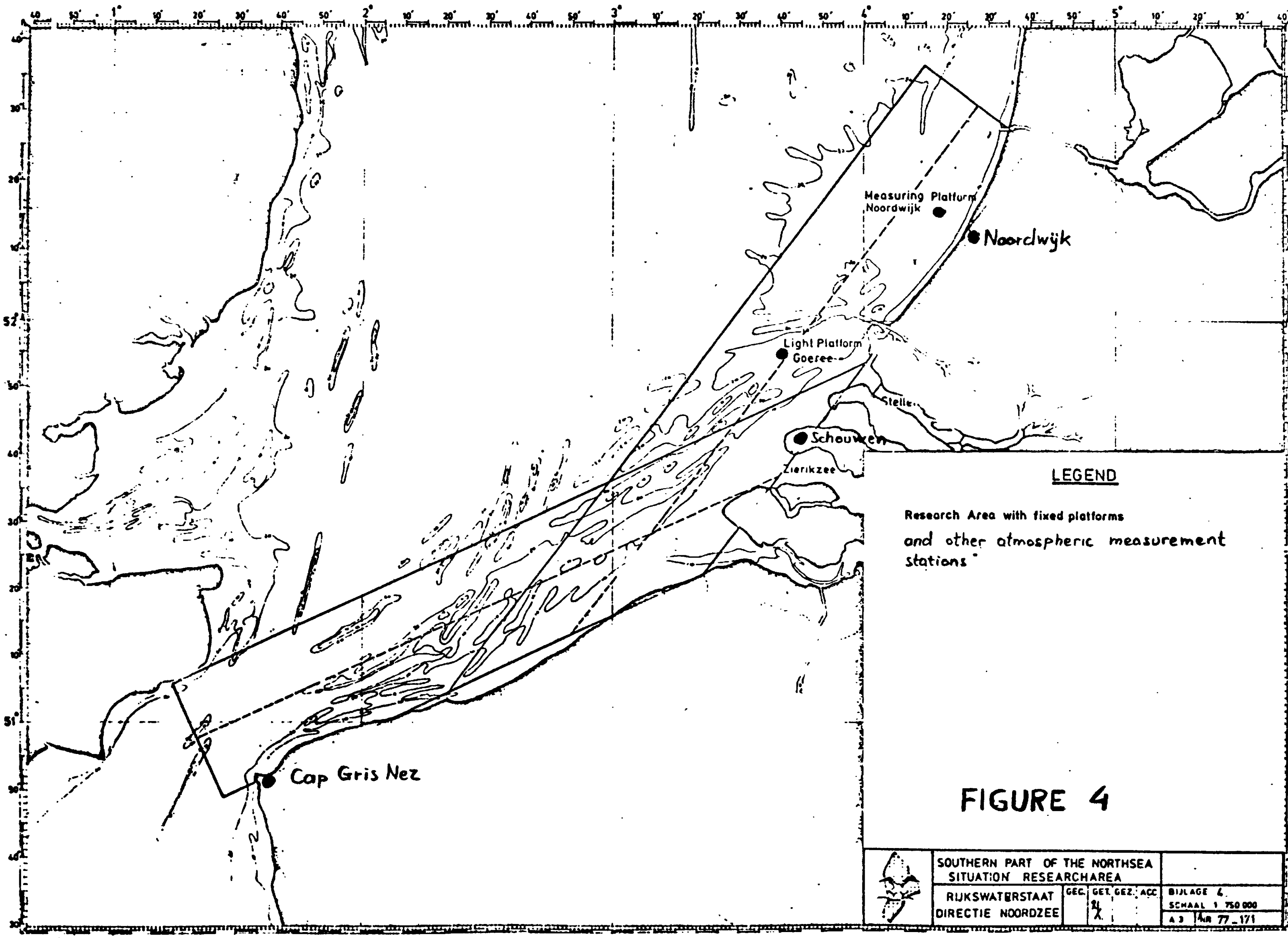

Measuring Platform
Noordwijk
Noordwijk
Light Platform
Goeree
Stelle
Schouwen
Zierikzee
Cap Gris Nez
LEGEND
Research Area with fixed platforms
and other atmospheric measurement
stations
SOUTHERN PART OF THE NORTHSEA
SITUATION RESEARCHAREA
RIJKSWATERSTAAT
DIRECTIE NOORDZEE
GEC.
GET.
GEZ.
ACC.
BIJLAGE 4
SCHAAL 1 : 750 000
A3
Nr 77_171

FIGURE 4

(Rijkswaterstaat):

1 Spectrometer

1 Albedometer

1 Irradiancemeter

1 Heiman KT 4 thermal IR radiometer

The plan was to measure on any "good" day during the stand-by period. All instruments should be intercalibrated bwfore and after the experiment. Most of the Exotech radiometers had been modified to measure in the first four spectral bands of the CZCS, namely 433-453 nm, 510-530 nm, 540-560 nm and 660-680 nm.

The primary objective of performing the atmospheric measurements would be to compensate the scanner data for the atmospheric effect.

The following parameters were to be measured:

- atmospheric transmittance (modified Exotech and ISCO radiometers)
- global irradiance (pyranometers)
- direct solar beam, i.e. sun irradiance (pyrheliometers)
- sky radiance at different azimuths and sun elevations for calculation of path radiance as a function of wave length in the 350-800 nm spectral range (EG and G 585 spectrometer)
- continuous incoming sun irradiance (unmodified Exotech radiometers - compatible with LANDSAT MSS bands)

6.6. Water related optical measurements

Optical instruments measuring upwelling and downwelling radiance and irradiance from the sea truth vessels, on floating rigs controlled from the vessels and from the stationary platforms should be included in the project. They were considered important for a later correlation with the aerial data after compensation for the atmospheric effect.

These measurements are, however, time consuming and were therefore difficult to fit into the tight schedule of the vessels. Consequently, the instruction was to measure as much as possible without interfering in the sea truth programme.

The following list describes the instruments available and their "carriers".

Optical underwater instruments

A One Belgian quantameter; on "Asselt" from Oostende

B One quantameter from DHI, Hamburg; on "Mechelen" from Zeebrugge

C One colour-ratio meter measuring the ratio of upwelling radiance at wavelengths 470 mm and 520 mm from Univ. of Copenhagen; on "Asselt" from Oostende

D One in-situ photometer with a spherical collector + colour filters to measure daylight irradiance from Univ. of Copenhagen; on "Asselt" from Oostende

E One irradiance meter from Italy; on "Octans" from Hoek van Holland

F One photo cell (in sea trugh package); on "Christiaan Brunings" from Hoek van Holland.

In addition to these instruments, radiometers would be used as follows:

A Belgian thermal infrared radiometer; on "Asselt" from Oostende

B 18-channel spectral radiometer provided by Univ. of Hamburg; on "Mechelen" from Zeebrugge

C PRT-5 thermal radiometer provided by CNR, Venice; on "Octans" from Hoek van Holland.

Rijkswaterstaat's unique spectrometer should be installed on the Noordwijk platform. It should measure upwelling net radiation from a position approximately 10 meters above the water surface. The instrument covers the spectral region 0.3-2.5 μ in 50 steps within 1 second.

Also a thermal infrared radiometer should be installed on the Noordwijk platform to measure water surface temperatures.

6.7. Water current measurements

The EURASEP Working Group assigned to produce oceanologic models for the project, had requested an installation of current meters at the outer boundary of the four OCS swaths to establish boundary conditions for a hydrodynamic model of the test site. The devices were placed in early June 1977 at the following positions:

1. $52^\circ 9'$ N - 4°E
2. $52^\circ 25'$ N - 4°E
3. $52^\circ 00'$ N - 3°E
4. $51^\circ 28'$ N - $3^\circ 11'$ E
5. $51^\circ 45'$ N - $3^\circ 30'$ E
6. $51^\circ 20'$ N - $2^\circ 38'$ E
7. $51^\circ 34' 30''$ N - $2^\circ 59' 10''$ E
8. $51^\circ 23' 05''$ N - $2^\circ 26' 20''$ E

6.8. Meteorological Records

Meteorological records were requested in advance from the Royal Belgian Meteorological Institute and Valkenburg Airfields meteorological observation station.

Meteo-observations and measurements should also be made at the atmospheric measurement stations.

7. THE OCS EXPERIMENT JUNE 19 - JULY 3

June 19:

The final adjustments on sea truth equipment were made on the vessels and equipment was brought to the off-shore platforms by ship and helicopter.

The atmospheric measurement stations proposed at the Noordwijk Beach and on the island Schouwen appeared to be inappropriate. A station was quickly arranged at Valkenburg airfield for the Noordwijk team and at Hamstede glider airfield on Schouwen for the other team.

The first weather forecast arrived in time from the Dundee tracking station. (The weather forecaster's report is given in Appendix VI).

The Mystere aircraft arrived in the late afternoon at Valkenburg airfield as scheduled, whereas the Dornier was delayed and did not arrive that day.

In the evening a last briefing was given by the test site coordinator for the atmospheric measurement teams in the Hague. The French team did not participate for logistic reasons.

June 20:

8 persons and the last equipment were carried to the off-shore platform by helicopters early in the morning.

A meeting at the Air Control Centre (ACC) in Schiphol, Amsterdam, with the flight crews was postponed one day due to the late arrival of the Dornier aircraft. Therefore it was a comfort to receive a weather forecast from Dundee stating that the entire North Sea was overcast and a flight within the next 24 hours was unlikely.

The scheduled communication with vessels, atmospheric measurement stations and platforms were made to build up a routine in the EURASEP Control and among the participants.

The Dornier arrived late in the afternoon.

June 21:
The meeting with the flight crews, the operations staff of the ACC, Schiphol, and the test site coordinator to make final arrangements for climb and holding positions for the Mystere and Dornier aircrafts was held at the EURASEP Control in the morning.

Based on the weather forecast, a "no go" message was given to all participants. The communication functioned well with the ships and off-shore platforms in Dutch waters except for the British vessel Zander, which could receive but not transmit on the given frequencies. Neither the Belgian nor the French vessels could be reached by the EURASEP Control on the mariphone. Therefore arrangements were made so that Radio Oostende and Radio Dunkerque Ouest could act as communication links between these vessels and EURASEP Control.

June 22:
The **weather** forecast from Dundee said "complete overcast". Calls to all participants confirmed that the entire operation was ready on stand-by and that an overall satisfactory communication system was established. An ad hoc weather information service was set up with the Royal Dutch Meteorological Institute and weather observations were called in from the off-shore platforms at frequent time intervals.

Dr. Morel* informed the EURASEP Control that a Cessna 337 carrying his prototype spectroradiometer had made a successful flight at 50 and

* Laboratoire de Physique et Chimie Marines, Station Marine de Villefranche-sur-Mer (F)

150 metres altitudes on June 21 over the French and Belgian part of the OCS experiment test site and at 300 metres over the entire test site on June 22. The data would be available to the EURASEP Project after elaboration.

June 23, 24 and 25:

The entire operation ready on stand-by. The weather was unsuitable for flights. Daily routine calls to all participants were made as scheduled.

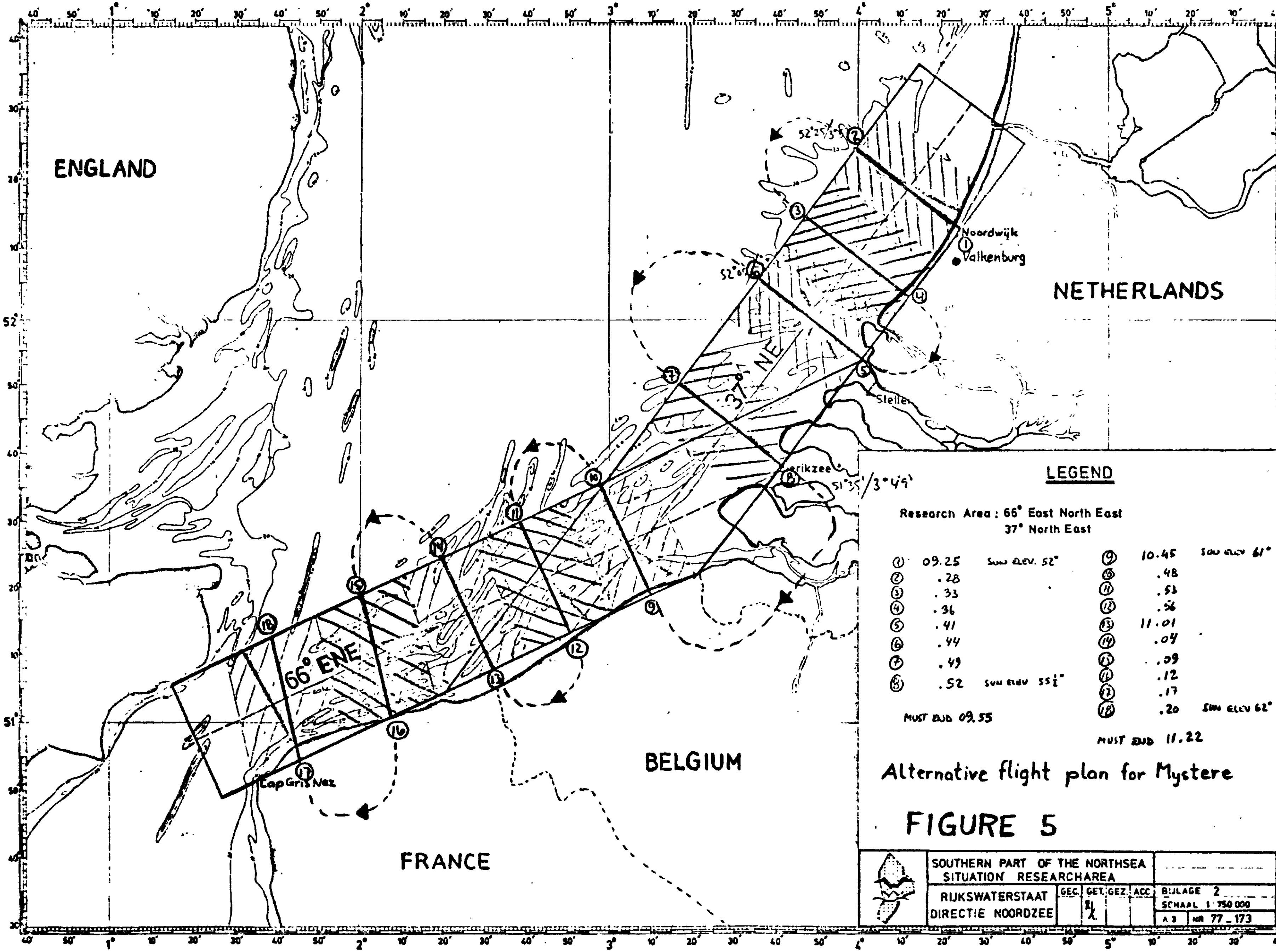
June 26:

A 72 hour weather forecast from two meteorological stations was discouraging. The project coordinator made an alternative flight plan after which a zig-zag pattern perpendicular to the original flight tracks could be followed (Fig. 5). With this plan, the mission could be carried out at sufficient sun elevation in the morning - before a build up of cumulus clouds might take place - without deviating more than the required $\pm 5^{\circ}$ from the sun angle.

The flight plan was discussed with the pilots and navigators at the EURASEP Control in the afternoon, and approved. The Air Control Centre (ACC) at Schiphol airport, Amsterdam, had yet to approve the plan and communicate it to the ACCs in Belgium, France and Great Britain. After the meeting with the pilots, a new time plan was worked out for the vessels by the coordinating team of the control centre.

June 27:

EURASEP Control received a telephone message from the Dundee Satellite Station in the morning that NOAA-5 pictures showed a hole in the cloud sheet over the North Sea which might be over the test site about 2 hours later. An immediate call to ACC, Schiphol, produced an approval of the new flight plan in less than 10 minutes and all participants were alerted. Most of the vessels arrived at their start positions in time. The remainders



Alternative flight plan for Mystere

FIGURE 5

were given ad hoc instructions over the radio.

The OCS was flown on schedule.
At 7.45 a.m. G.M.T., most of the test site was covered with clouds. At 9.28 a.m. the site was cloud free, and at 11.22 a.m. the site was completely overcast. This sequence is documented by three series of NOAA-5 images.

During the 60-90 minutes of cloud free conditions, the Dutch part of the test site was flown with the OCS, data was collected from five vessels in Dutch waters and four atmospheric stations measured.

Within this short period of operation, good data was acquired by the LANDSAT-2 MSS and the NOAA-5 VHRR over the test site as well.

When the Mystere aircraft was entering over the Belgian and French part of the test site, the cloud sheet had closed.

The execution of the operation was first of all due to the ACC's exceptionally rapid approval of the flight plan after a telephone discussion only. It was given in ten minutes rather than in 10 hours. It was therefore fully acceptable but nonetheless unfortunate that the Dornier aircraft did not enter its scheduled track before the clouds had closed over the test site.

June 28:
Weather unsuitable for flights. Detailed instructions on timing for the vessels as related to the alternative flight plan was communicated to all sea truth teams.

June 29:
A message from Dundee on a hole in the cloud sheet over the southern flight track (Belgian and French coast) was received at EURASEP Control in the morning. All participants were given instructions to follow the alternative plan.

The Mystere and Dornier aircrafts acquired data over Belgian coastal waters under cloud free conditions but the French part of the test site was overcast by the time the aircrafts entered over this area.

The vessels from French and Belgian ports ran a complete sea truth programme while the ships in Dutch waters collected only a few water samples in order to save sampling bottles for a potential second full sea truth mission in this area.

The atmospheric measurement stations did not measure as none of them was situated within the cloud free area.

The Cessna 402 identified names and positions of eight ships at anchor in Dutch waters. Unfortunately the cloud sheet did not open in this area. It may therefore not be possible to utilize this information.

<u>June 30, July 1 and 2</u>:
The entire operation ready on stand-by. The weather was unsuitable for flights. Daily routine calls to all participants were made as scheduled for original and alternative plans.

<u>July 3</u>:
The entire test site was reported to be cloud free by the meteorological stations, the off-shore platforms and the sea truth teams. Some haze-particularly over the Dutch part of the site - gave rather poor horizontal visibility, but reasonably good vertical visibility. The haze decreased considerably during the afternoon.

The whole test site was flown by the Mystere according to the alternative plan. Some icing on plexiglass in front of the OCS scanning mirror was reported. The impact of the icing is not known at the time of writing but it is not expected to be severe. The Mystere returned to Valkenburg air-field for refueling after having completed the alternative plan and flew the southern track as originally scheduled, without icing problems.

The Dornier flew the whole test site at good cloud free and visibility conditions. The flight was made parallel to the coast line and due to delays on refuelling in France, the sun position was unfavourable during the outer track return flight from Cap Gris Nez to Valkenburg.

The Cessna 402 recorded names and positions of a number of large ships during the day. Thus it provided a valuable contribution to the project.

All vessels made a full sea truth programme for the mission following the alternative plan in the morning. A full programme was again made by the Belgian vessels to support the afternoon flight (original plan), while the French vessels did not receive the instructions to go a second time and stayed at port.
All atmospheric measurement stations were in operation throughout the day.

The water samples were collected by a freeze van from all nine ports of sea truth vessels on July 4 and brought to a laboratory in Deventer, the Netherlands, for analysis.

A summary of "Primary Vehicles and Sensors Operating during OCS Missions on June 27, June 29 and July 3" is given in Appendix IV.

8. ASSESSMENT OF THE PLANNING, COORDINATION AND EXECUTION OF THE OCS EXPERIMENT

The OCS experiment is probably one of the most extensive remote sensing compaigns ever made in Europe. Therefore, it may be fair to say that relatively little experience has been gained in this scale of data acquisition previously in Europe. This may be true for remote sensing in general and - for remote sensing in oceanography and on the coastal off-shore environment in particular.

It is with this in mind that the project coordinator has called for critical comments from all participants - negative and positive - with emphasis on problems that could be of value for future projects of the same nature. The following is a compilation of written and oral comments from participants at sea, in the air and at the atmospheric measurement stations.

8.1. Sea Truth

Customs clearance:
It seems to be a trivial problem but many teams - though well prepared - encountered great difficulties in crossing borders with their equipment. It is suggested for future internations EC sponsored projects that EC issue a letter for the customs, stating the nature of the project and calling for cooperation.

Tech-in:
Only positive comments on that event. It may be useful in the future to invite the captains of all participating vessels to the teach-in or as an alternative, send copies of all material that goes to the sea truth team leaders including a general description of the project. Most team leaders have reported excellent cooperation with the captains and crews.

Intercalibration of instruments:
It has been said over and over that the opportunity to see the equipment of the other teams at work plus the social effect of this event made up for all the problems encountered during the intercalibration. However, it was a new experience for most participants and everybody learned a great deal from the session. Some problems:

- the barrels used for transportation of the water from the sampling positions to the laboratory were not clean. Paint and rust particles were suspended in the water after the transport;

- 2 x 600 litres was far too little volume for the purpose. Each "type" of water should rather have been present in the order of a few cubic metres;
- the water was heated by a submerged pump. Since the temperature measurements were not made at the same time by all teams, the results may be of only limited value;
- a large variety of instruments measuring each type of parameter made a real correlation of results difficult. It has been suggested that all EURASEP teams obtain a standard sea truth package. This ideal solution may be unrealistic for financial reasons.

Project coordination:

More general views on the overall coordination than precise comments have been given, although the participants were urged to critisize the project coordination uninhibitedly. Since many participants are specialists in certain aspects of oceanographic work, it has been proposed that experts on each specific parameter meet in small groups to standardize the measurement methods, to define the accuracies and to decide upon a systematic elaboration of the data. This shall be seen in contrast to the previous discussions in the Sea Truth Working Group where often 15 - 20 persons were together for 1 - 2 days to run through an agenda with only very short time to deal with each parameter.

Some team leaders have expressed that the details given to them in advance about the vessels they should be working on, were indeed adequate. Yet, there are points to note for change or improvement. It was found that the freeze storage space was too small on some vessels. On-board filtering of chlorophyll appeared to be difficult on the smaller vessels due to limited space and a more dramatic movement of the ship. A wash bottle was found to be a handy but missing item on several vessels.

Secchi disc measurements and the related optical measurements and observations also appeared to be difficult from the small vessels where movements of the ship were an obstruction to obtain a desired accuracy.

Large part of the test site covered very shallow waters. Although the bathymetry had been considered for each ship track, at least one vessel found that a correct course could not be followed at low tide. The same vessel had a major sail boat regatta crossing the track during a few days of the stand-by period. This could probably have be known in advance by calling the marine authorities.

The floating intake used for continuous collection of water needs improvement. One team leader has recommended the following changes for the entire system set up for continuous measurements:

- intake boat should be of catamaran type, of about the following size: hull length - about 2 m; beam - about 0. 5 m; hull separation - about 1 m. This should be towed by an adjustable bridle forward of the bow;
- the impellor pumps should be replaced by piston or diaphram types of pumps;
- fluorometers and turbidity meters should be supplied from a by-pass system or from a small gravity feed header tank to solve any problems of bubbles in the pumped water system;
- to ensure comparability of data, all equipment should be as similar as possible (see also intercalibration).

The sampler and Secchi discs constructed at the JRC, Ispra, functioned well. No samples were taken at greater depth than 18 metres. This type of sampler is generally not expected to work well at depths greater than 30-40 metres.

Communication was a problem in many ways. Too late it was revealed that some of the vessels could neither receive nor transmit on the chosen frequency because they did not have the right crystals. Though the sea truth teams could be reached by phone while being at port, and by radio when they were at open sea, there would be an intermediate time lapse where direct communication was not possible. The official language was English.

Nevertheless most of the radio communication with Dutch vessels was in Dutch. This rightfully caused irritation among some team leaders who could hear the conversations but not understand them. One vessel could receive but not transmit on the selected frequency. This meant that a person had to sit at the receiver all the time during the operations in order that all messages from EURASEP Control were securely received. That could have been avoided if all messages had been transmitted in English 2 - 3 times at certain time intervals. Future projects will benefit from an improved land-sea and sea-sea communication system. It worked well for all Dutch vessels but was clearly not satisfactory for the other vessels.

A proposed design and description for a communication centre is given in Appendix V.

Perhaps the biggest problem had been given least attention because it was not anticipated. The sea truth teams working on foreign vessels, could not return to their home laboratory or office when the "no go" message was given. They were left to wait on board the ships or at their hotels for the message of "go" or "no go" the following day - with nothing to do. During the first week without action the EURASEP Control kept the teams informed about the weather forecast and thus the prospects for going. It build up despair among many participants as the possibility of no action at all seemed more and more likely. Some team leaders have suggested that future projects are planned in such a way that daily oceanographic mission would be made independent of flights. When the weather situation was suited for flights another combined sea truth - flight programme should be realized. With such a schedule neither vessels nor teams would be idle and useful data would be collected.

A total of almost 500 bottle samples were taken during the experiment. They were collected by a freeze van on July 4, immediately after the last day of the stand-by period. Storage of the samples was poorly organized.

A very efficient effort by a Rijkswaterstaat employee in the last moment prevented a total confusion. The lesson to learn from this is that future projects of that size and nature should include a person specifically assigned to organize an appropriate storage and transportation of the water samples.

8.2. Flights

Fuel, oxygen, hangar space, electric charging, etc. was well prepared as was the permit to enter the air base. However, because landing and take-off took place at a military air field, special procedures for paying fuel and landing fees had to be followed. Customs clearance caused problems on Sunday.

As to the preparation and execution of the flights, it is advantageous that the pilots and navigators meet well in advance - preferably also with the air controllers - to establish rate of climb, holding circuits, flight plan, refuelling conditions, etc.

It should be remembered that an established flight plan cannot be changed (with few exceptions) once the aircraft has taken off. If a flight plan does not satisfy the preset conditions, due to sudden changes in weather or for other reasons, the flight should be continued or cancelled, allowing the aircraft to return to base and file a new flight plan.

8.3. Atmospheric measurements

The facilities for the teams on the off-shore platforms were ideal, while the importance of providing the land based teams with similar facilities had been underestimated in the planning stage. Though the teams had power generators, the consumption exceeded the capacity of these and an additional source of power was needed. The noise of generators driven by petrol engines can be a nuisance for residents and other people in the vicinity. Consequently an atmospheric measurement station should be chosen with care. In both cases here, airfields were chosen. They were flat with no shading structures, had a high noise level tolerance, and provided an extra source of electrical power.

9. DOCUMENTATION

The data acquisition campaign described in this report has been well documented. A 16 mm color film (15 min) as well as a black and white video film (50 min) have been made of the project. Approximately 150 color slides filed at Ispra are at disposal for composing picture shows.

10. DATA ARCHIVATION AND DATA ANALYSIS PLAN

The raw data has been filed at JRC, Ispra. It is undergoing a computer oriented format before entering into a data bank. This part of the project will be described in a separate report in February/March 1978.

The OCS preprocessing and processing as well as the analysis of air and sea truth data will take place in spring and summer 1978. The goal is to describe this work in a third and final report before September 1978.

11. ACKNOWLEDGEMENT

The EURASEP Working Groups had done a good deal of preparatory work for the project during their first half year of existance. When the detailed planning and coordination started in early March 1977, the group preparing the OCS experiment could benefit from that work. However, three months to plan a project as complex as this experiment is extremely short

time, and many people were involved in this work. Large or small, all the contributions from institutes and individuals were important! A few persons were deeply engaged in the planning from the start to the end. They deserve to be mentioned for their tireless efforts during that stage of the project. Dr. J.A. Charlton* made a major part of the sea truth plans. Ir. J.W. van Rijn van Alkemade** was coordinating the Dutch participation and arranged numerous facilities for the experiment in total. Mr. H. Picard*** coordinated the Belgian participation and made all local arrangements for the intercalibration and the teach-in at Ostend. Mr. F. Sorel**** build several units of the chain of electronic equipment needed to operate the OCS and supervised the construction of the digitizer in that system. It is obvious that these persons were backed by their home institutes. This support is sincerely appreciated by the principal investigator of the EURASEP project and the campaign coordinator of the OCS experiment.

NASA's service was excellent. Particular commendable was the guidance and assistance given by Dr. W. Barnes and Mr. J. Semyan at Goddard Space Flight Center.

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* University of Dundee (GB) and chairman of the EURASEP Sea Truth Working Group

** Rijkswaterstaat, Direction North Sea (NL)

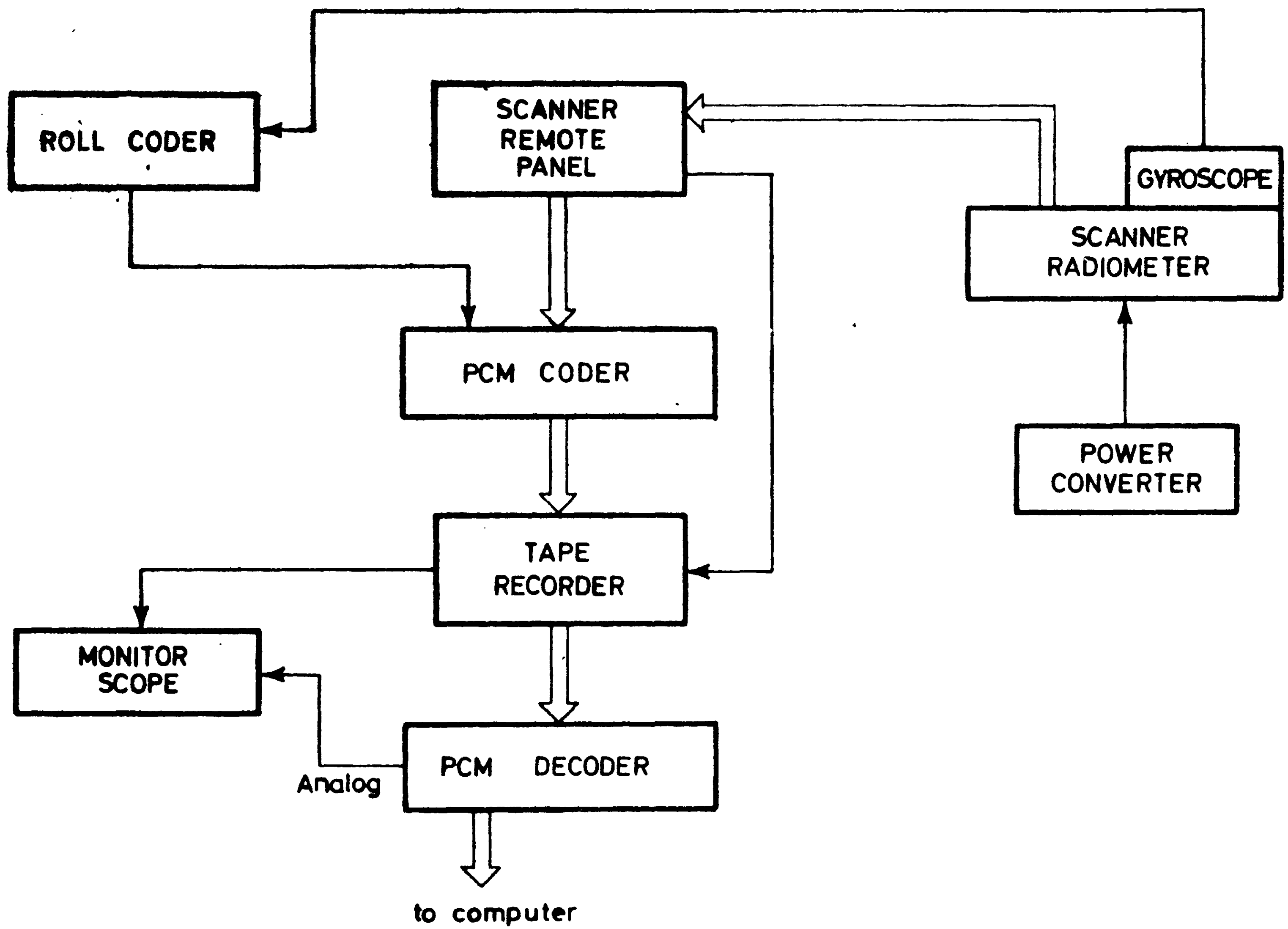
*** Ministere de la Santé Publique et de la Famille - Secretariat d'Etat a l'Environnement - Unité de Gestion du Modèle Mathématique de la Mer du Nord (B)

**** Joint Research Centre, Ispra (I)

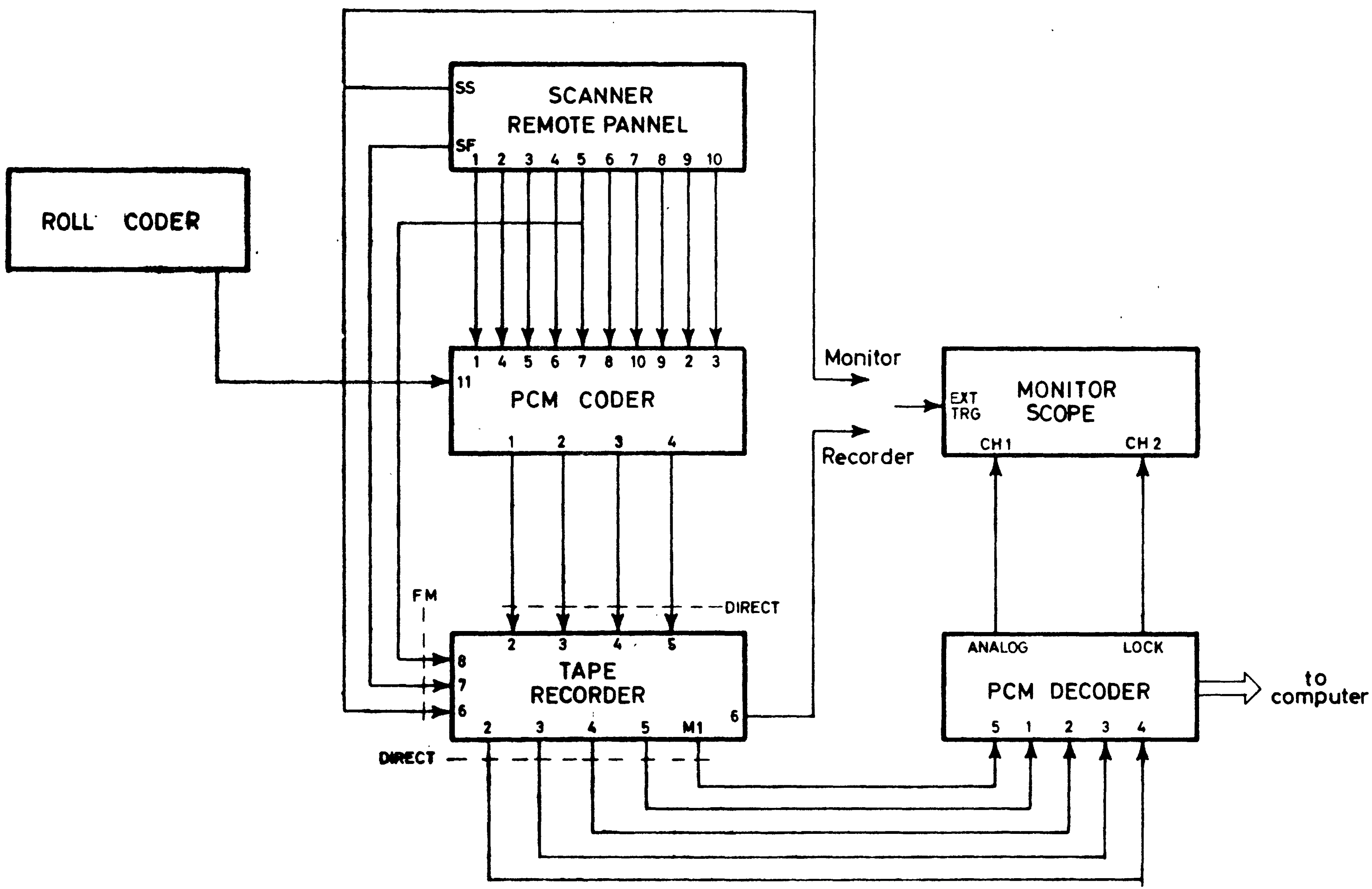
APPENDIX I

Characteristics of the Ocean Color Scanner System

OCS ACQUISITION SYSTEM

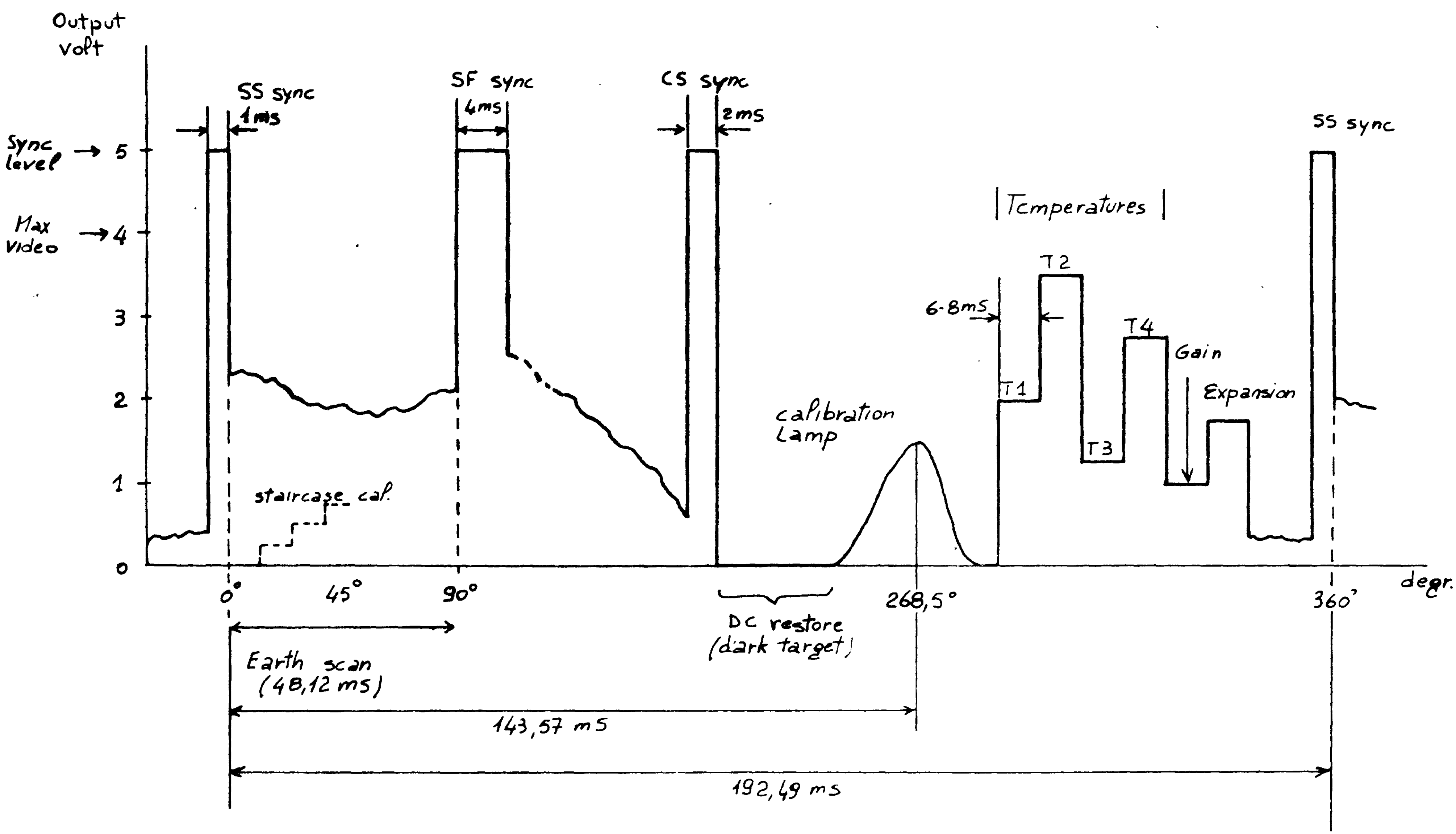


SIGNAL FLOW



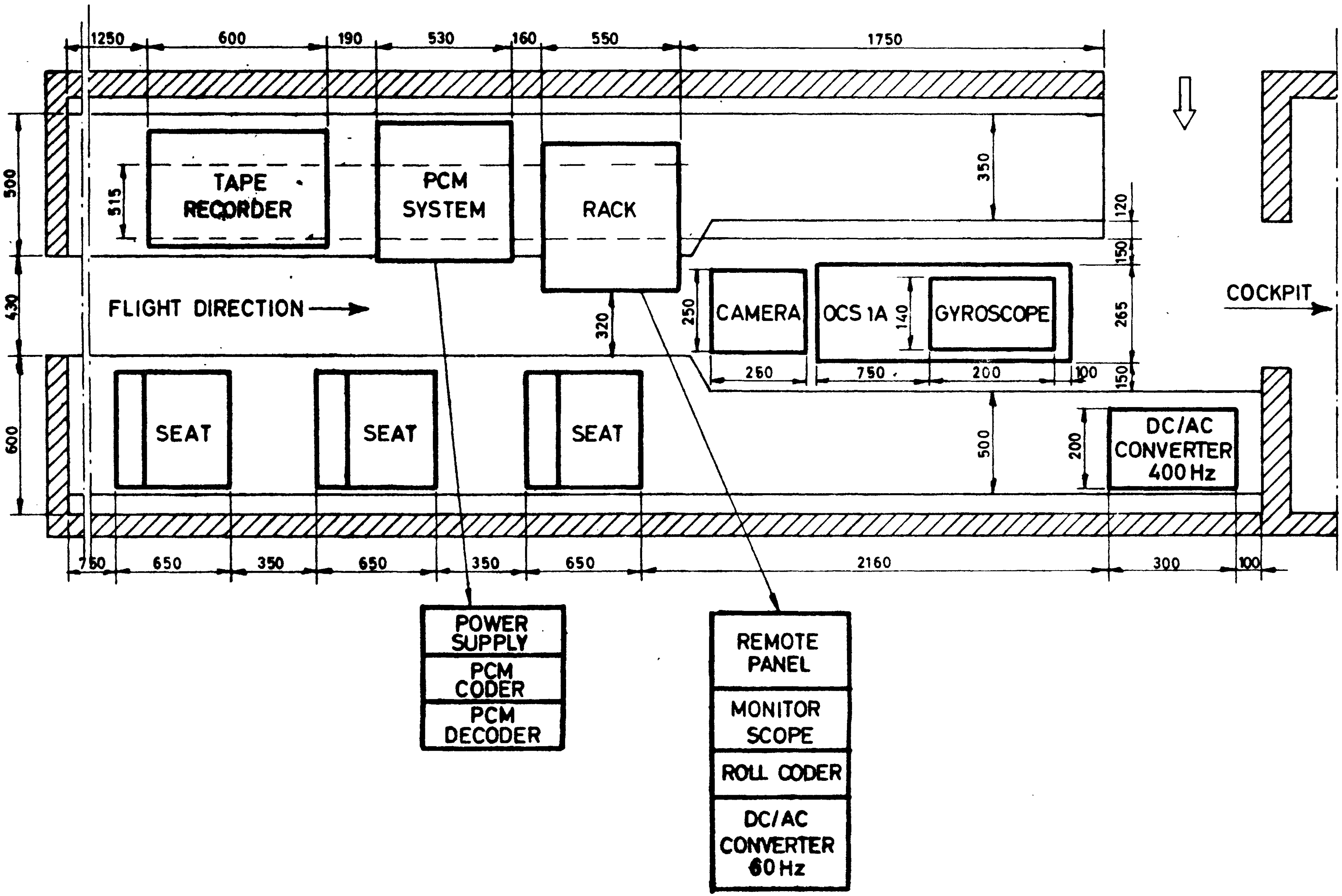
ROLL CODER
SCANNER REMOTE PANNEL
SS
SF
1 2 3 4 5 6 7 8 9 10
PCM CODER
1 4 5 6 7 8 10 9 2 3
11
1 2 3 4
TAPE RECORDER
2 3 4 5
8 7 6
2 3 4 5 M1 6
FM
DIRECT
DIRECT
Monitor
Recorder
MONITOR SCOPE
EXT TRG
CH1
CH2
PCM DECODER
ANALOG
LOCK
5 1 2 3 4
to computer

Video format OCS



4

INSTRUMENTS LOCATION



F. Sorel

OCS characteristics Working paper N. 1

This working paper deals with the main characteristics of the Ocean Color Scanner N. 1 developed by NASA, Goddard Space Flight Center, and used in the EURASEP project. At present there are two scanners OCS N. 1 and OCS N. 2 which differ slightly (particularly the angular resolution). The OCS is a 10 channel scanning radiometer. It has a 90 degree field of view (FOV) and a 3. 5 milliradian instantaneous field of view (IFOV). The following data are referred to the experiment conditions of EURASEP.

1. Radiometer

Aircraft speed : 200 meter/sec
Aircraft altitude : 11000 meter (nominal)
Angular resolution : 3, 5 mr
Pixel at nadir : 3, 5 mr x 11000 m = 38. 5 m x 38. 5 m
Field of view (FOV) : $\pm 45^{\circ}$ from nadir
Number of pixels per scan line: 2π : 3. 5 = 1795
Number of pixels per earth view portion: 1795 : 4 = 448. 75
Swath width : 22 kilometers
Scan rate (mirror speed rotation): 200 m/s : 38. 5 m = 5. 195 rev/sec
Scan period : 192, 493 ms
Earth scan duration : 48. 12 ms
Scan angle variation : 1. 8702 deg/msec (0. 5347 ms/deg)

2. Optical system

The OCS optical system consists of a rotating scan mirror, a Dall-Kirkham telescope, an optics box and an array of ten detectors. The scan mirror reflects the image onto the 127 mm primary collecting mirror. The telescope has a focal length of 283 mm at F 2. 25. A lens tube which houses a 1 x 1 mm aperture, a solenoide operated shutter, and a focussing

lens (achromatic refracting collimator) connects the telescope and the optics box. The (1 mm)^2 aperture is at the focal point of the telescope and serves to set the radiometer's spatial resolution at 3.5 mr. The shutter is used during calibration to block all light from the detectors.
The optics box contains the diffraction grating, the focussing mirror and the glass pipe array. The grating is (26 mm)^2 with 600 lines per millimeter. Ten glass pipes are routed to the ten detectors and preamplifiers.

Optical parameters:

Channel	Center wavelength (nm)	Full width at halfheight bandwidth (nm)	Radiance (Gain x 1) mw/cm^2 μ
1	433	22.5	40.10
2	471	21.5	26.00
3	509	27.5	23.60
4	547	24.5	14.70
5	583	25.0	11.80
6	620	26.0	10.00
7	662	22.0	7.55
8	698	20.5	5.00
9	733	22.5	11.90
10	772	23.0	3.47

3. Electronic system

The electronic circuits are partly in the scanner, partly on the remote control panel. The preamplifier and DC amplifiers in the scanner bring the maximum expected signal of the detector to a 4.0 Volt level. Four thermistors mounted in the baseplate of the scanner telescope, detectors and optics monitor the temperature. Magnetic pick-up devices installed on the mirror rotation shaft deliver the following timing pulses:

- SS SYNC : start of earth scan
- SF SYNC : end of earth scan
- CS SYNC : start of calibration phase

These pulses have a 5.0 Volt level.

On the front panel ten rotary switches allow each channel's gain to be multiplied by 1, 1.5, 2 or 3. The expansion control switches, also located on the front panel, are used to produce a gain and offset in the following manner:

Expansion x 1		Expansion x 2		Expansion x 4	
1 Volt	1 Volt	1 Volt	0 Volt	1 Volt	0 Volt
2 Volt	2 Volt	2 Volt	0 Volt	2 Volt	0 Volt
3 Volt	3 Volt	3 Volt	2 Volt	3 Volt	0 Volt
4 Volt	4 Volt	4 Volt	4 Volt	3.5 Volt	2 Volt
				4 Volt	4 Volt

Thus, with the switch in position 4, the top 25% of the signal is spread across the full 4 Volt range. This is useful in ocean colour work because most of the information is contained in the top 10% of signal whereas the remainder of the signal is caused by atmospheric radiance.

In the box of the remote control panel the video signal, the sync pulses, the temperature indication, the position of the gain and expansion switches are mixed together and are routed to the data channel connectors.
The composite video format is illustrated in the next figure.

Remote front panel

Switches :
- power
- door close/open
- temperature selection for display
- 10 for gain, 4 positions
- 10 for expansion, 3 positions

Push buttons:
- dark calibration (actuates shutter of telescope)
- staircase calibration (generates a staircase on all data channels in the earth scan interval, 17 steps of 250 mV, duration 5 ms

Connectors:
- 10 data channels
- SS SYNC
- SF SYNC
- CS SYNC

F. Sorel

<u>OCS experiment instrumentation</u>   <u>Working paper N. 2</u>

The electronic instrumentation installed on aircraft for the OCS experiment comprises:

a) scanner
b) remote control panel of OCS
c) power converter
d) digitizer (PCM System)
e) recorder
f) oscilloscope
g) coder of roll information

The scanner OCS (a) and its remote control panel (b) are described in the Working paper N. 1 "OCS characteristics". The specifications of the digitizer, the quick look facility and the recorder are given in the Working paper N. 3 "OCS data acquisition system". Thus, this paper deals only with the remaining equipment.

Power converter

The power converter is required for the alimentation of the OCS scanner with 115 V, 60 Hz. Since on the aircraft the only supply voltaged are 28 V/DC and 115 V/400 Hz, the converter delivers the 115 V/60 Hz from the 28 V/DC.

Sine wave inverter:

- nominal output power: 100 VA
- input voltage: from 20.4 V DC to 31.2 V DC
- output voltage: 110 V $\pm$ 5%
- wave: sine
- distortion: 5%
- efficiency: 70%

(cont.)

- operating temperature: -10 +55°C
- protected against short circuit, overload and polarity inversion
- weight: 13 Kg

Oscilloscope

The oscilloscope is required for the test of the whole OCS experiment instrumentation during installation and for the monitoring of the recorded data during flight.

- portable, dual trace
- bandwidth: 200 MHz
- sweep rate: 1 ns/div
- calibrated display: 8 x 10 cm
- automatic Volt/Division read out
- delayed sweep
- sensitivity: 2 mV/Div
- operating temperature: -15°C to +55°C
- power requirement: 115 V, 48 to 440 Hz, 100 W
- weight: 11.5 Kg

Coder of roll information

Since on the aircraft there is no electrical signal available which indicates directly the roll angle, a coder is required to extract this information from the aircraft navigation system. The available outputs of the navigation system are 3 phase tensions. The voltage difference and/or phase angle between these signals give the roll information. The output of the coder will be connected to the digitizer and recorded on the high density data tape. Two channels of the data acquisition system are reserved for this information.

F. Sorel

OCS data acquisition system   Working paper N. 3

The acquisition system includes the digitizer, the magnetic tape recorder and the quick look facility on aircraft. The ten data channels of the Ocean Color Scanner, the time code, the identifier and the available information of the aircraft navigation system are recorded on 4 PCM (pulse code modulation) tracks of the high density data tape. Since the time code and identifier are inserted on each track, there are no correlation problems (deskew, jitter) between tracks and each track can be read separately. The quick look facility provides monitoring and test of the total data acquisition. It consists mainly of a reproduce channel with PCM decoder which displays the content of any data channel recorded on one of the four tracks during the acquisition phase (read after write).

A) Digitizer

Number of external inputs	: 12 (11 analog, 1 digital)
Input range	: 0 to 5 Volts (adjustable)
Input filters	: 6 poles
Resolution of A/D converters	: 10 bits (= 1024)
Sampling rate	: 9000 Hz, simultaneous on all channels (sample/hold on each channel)
Number of PCM outputs	: 4
PCM code	: enhanced NRZ or biphase, for OCS experiment: enh. NRZ
PCM output rate per track	: 450 Kbit/sec
Total PCM output rate	: 1.8 Mbit/sec
Bits per word	: 10
Frame synchronization	: 2 x 10 bits
Time code	: 3 x 10 bits triggered with frame frequency display on PCM decoder Reset on front panel

(cont.)

Frame frequency : 3000 Hz

Identifier : 1 x 10 bits, selectable by switches on front panel

Format:

PCM output 1 :	Word	1	Frame Sync, part 1				
	"	2	"	"	"	2	
	"	3	OCS	channel	1,	sample	1
	"	4	"	"	5,	"	1
	"	5	"	"	9,	"	1
	"	6	Time code, part 1				
	"	7	"	"	"	2	
	"	8	OCS	channel	1,	sample	2
	"	9	"	"	5,	"	2
	"	10	"	"	9,	"	2
	"	11	Time code, part 3				
	"	12	Identifier				
	"	13	OCS	channel	1,	sample	3
	"	14	"	"	5,	"	3
	"	15	"	"	9,	"	3

S1, S2, C1, C5, C9, T1, T2, C1, C5, C9, T3, ID, C1, C5, C9, S1 ...

PCM output 2 :

S1, S2, C2, C6, C10, T1, T2, C2, C6, C10, T3, ID, C2, C6, C10, S1 ...

PCM output 3 :

S1, S2, C3, C7, C11, T1, T2, C3, C7, C11, T3, ID, C3, C7, C11, S1 ...

(C11 = Roll information, part 1)

PCM output 4 :

S1, S2, C4, C8, C12, T1, T2, C4, C8, C12, T3, ID, C4, C8, C12, S1 ...

(C12 = Roll information, part 2)

Word rate per track	: 45.000 words/sec
Available recording time	: 1 hour
Words per PCM track	: 45.000 x 3600 = 162 Meg
Total word number	: 162 x 4 = 648 Meg

B) Recorder

- configuration: portable, wideband
- tape width: 1 inch
- number of tracks: 14
- bandwidth of direct record/reproduce: 1 MHz at 60 ips
  250 KHz at 15 ips
- reel diameter: 10.5 inch
- tape speeds: 60, 30, 15, 7 1/2, 3 3/4, 1 7/8, 15/16 ips
- recording speed: 15 ips
- bit density on tape: 30 Kbit/inch
- data frequency spectrum: 225 KHz
- available recording time: 1 hour with 4600 feet tape
- electronic modules: 4 direct, 3 FM (2 speeds)
- monitor unit for any record input or reproduce output
- vibration mount
- footage counter

C) Quick look facility

- PCM decoder: 1
- track and data channel selectors on front panel
- bypass position of tape recorder for PCM system test
- display of any channel content: decimal form/binary form
- continuous decimal display of time code reproduced from tape or from digitizer output in tape bypass position

(cont.)

- outputs of any selected channel: analog for monitor oscilloscope
  digital on word basis for computer
- monitor oscilloscope: dual trace, external trigger by SS pulse of OCS recorded on FM track
- indicators of bit and frame synchronization
- selectors for number of channels in normal commutation, in overcommutation and number of overcommutations per channel (this feature is useful for a future conversion of the system to other applications)

F. Sorel

<u>Operation of OCS equipment in flight</u> <u>Working paper N. 4</u>

This paper deals with the sequence of operations with the OCS instrumentation during flight. Most information is based on the experience of the NASA Lewis Research Center at Cleveland which has used the OCS for about two years.

1) Establish the flight lines of interest for the OCS measurement considering the sun angle. The flight line has to be in sun or out sun (in front or behind) because a different sun angle causes a considerable loss of video data and actually the NASA center has no software for correcting this effect during data processing. The condition of the sun angle defines the hour of flight for each line and day.

2) Introduce the end coordinates of flight line in inertial navigation system (INS) of the aircraft. The pilot has to stay between the end coordinates on a straight line without trying to correct his position if deviation from defined line occurs. The coordinates of line begin are fixed about 80 miles before the measurement zone to allow the OCS operator to perform some operations; the coordinates of line end are fixed about 20 miles behind the measurement zone.

3) Before the flight starts, the OCS operator carries out the following steps:
   - turn power on of converter, OCS (warm-up time 15 min), PCM system, recorder, oscilloscope, roll coder;
   - initiate tape;
   - calibrate time code counter (reset and note time)
   - set identifier of PCM system (flight number or date)
   - check display of time code (run) and display of the single data channels with track selector on tape bypass position; monitor on oscilloscope the different signals (f. i. sync pulses of OCS).

4) During the flight over the measurement zone, the OCS operator has to set the gain and expansion switch of each channel to an appropriate value monitoring the video signal on the scope. Since there are totally twenty switches to set this operation needs some time and the aircraft has to fly over the measurement zone until the calibration in flight of OCS is ultimated.

5) After this operation, the aircraft flies to the initial coordinates of the first line; when aircraft reaches these coordinates, the OCS operator starts the magnetic recorder and generates a staircase calibration at the OCS output in order to check the linearity of data during data processing.

6) After 20 miles of coordinates of flight line begin (begin of measurement zone), the OCS operator generates a dark calibration of OCS actuating the telescope shutter, note the display of time code and the coordinates communicated by the aircraft navigator. The dark calibration causes the output of all data channels to go to zero and generates a dark line on the picture generated during preprocessing (limit of good data).

7) 20 miles before the coordinates of flight line end (end of measurement zone), the OCS operator performs the same operations as under point 6). Thus the good data portion is limited by two dark lines and the geographical location is referred to the coordinates of the dark calibration lines.

8) When aircraft reaches end coordinates of defined line, the OCS operator switches off the tape recorder. The aircraft turns back and goes to the next flight line; the operations described under points 5), 6), 7) and 8) are repeated.

The staircase calibration at the begin of each flight line is used for the determination of grey levels for film recorder or graphical computer terminal. The scanner and digitizer are always running but the tape recorder is started and stopped. Therefore a loss of synchronization occurs on the end coordinates, outside of good data portion.
During flight the OCS operator notes the following information:

- flight line, aircraft speed, drift angle, time code and coordinates for the executed operations like dark calibration, tape recorder start a. s. o.

APPENDIX II

Flight plans and sensor specifications for the
B-17 aircraft contributed by France

FLIGHT PLAN   AIRCRAFT B.17

	Start	End	Direction
Take off from Creil	12.20		
Leg B	13.00	13.16	S — N
Leg D	13.31	13.36	N — S
Leg C	13.41	13.52	SW — NE
Leg A	14.34	14.49	246° (true heading)

Altitude: 5000 metres.

Remarks:

1) Leg A should be flown simultaneous with the Mystere flight over EURASEP Leg II.
2) Legs B and C could be flown independent of the Mystere flight (even on a different day).
3) In case of a delay during the flight over Legs B and C, these flights should be stopped in time to start on Leg A as scheduled. Leg A has highest priority.
4) If the meteorological conditions do not permit a flight over Leg A, while Legs B, C and D are cloud free, the last three legs should be flown with Legs B and D given highest priority.
5) If the Legs B, C and D cannot be flown prior to Leg A, they should be flown afterwards, if possible.

SENSOR PRIORITY

The priority of sensors on the B.17 aircraft is the following:

1) Daedalus scanner (channels 1-2-3-4-5-8)
2) Push broom

(cont.)

3) SAT scanner

4) Wild metric camera with colour film

5) Wild metric camera with + X film

SENSOR SPECIFICATIONS

	Daedalus scanner	
Spatial resolution	: 2.5 m rad.	
Channels:	1	0.38 - 0.42 μm
	2	0.42 - 0.45 "
	3	0.45 - 0.50 "
	4	0.50 - 0.55 "
	5	0.55 - 0.60 "
	6	0.60 - 0.65 "
	7	0.65 - 0.70 "
	8	0.70 - 0.80 "
	9	0.80 - 0.90 "
	10	0.90 - 1.10 "
Scan speed	: 20 r.p.s.	
F.O.V. (total)	: 77°	
Ne$\Delta\rho$	: 3% at 0.4 μm and 1% elsewhere	
Recording time	: Leg A - 14 min.	
	Leg B - 15 min.	
	Leg C - 10 min.	
	Leg D - 6 min.	

Push-broom

Spatial resolution : 0.5 m. rad.

Channels with the filters selected for this campaign:

		λc	$\Delta\lambda$
camera 1	filter no 1 or 2	443 nm	20 or 50 nm
camera 2	filter no 4	520 nm	20 nm
camera 3	filter no 7	542 nm	45 nm
camera 4	filter no 9	650 nm	26 nm

F.O.V. (total) : 14^{o}

Polarisation filters will not be used for this campaign.

Recording time : as for Daedalus scanner.

SAT scanner

Spatial resolution : 1.7 m. rad.

Channels:

	λc	$\Delta\lambda$
1	4.71 μm	1.6 μm
2	7.95 "	1.4 "
3	9.1 "	1.8 "
4	10.5 "	2.3 "

F.O.V. (total) : 90^{o}

NeΔ T : $0.20^{o}K$

Internal black body calibration

Recording time : as for Daedalus scanner.

Wild metric cameras

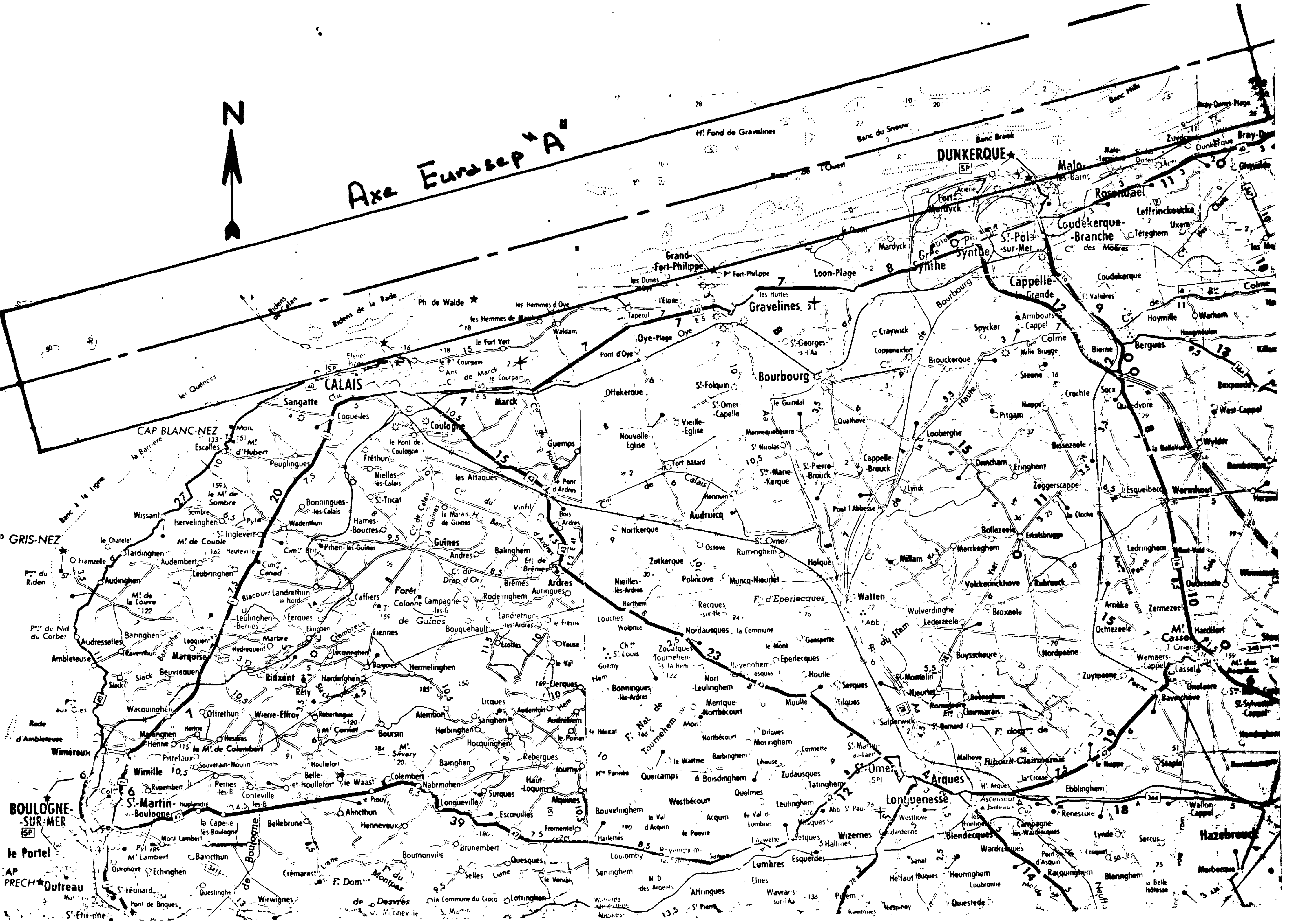
Camera	Type	Focal length (mm)	Emulsion	Overlay %	Number of exposures
1	RC8	152	natural color	60	78
2	RC9	88	+ X	77	78

With 60% overlap it should be possible to compose a mosaic without specular reflection.

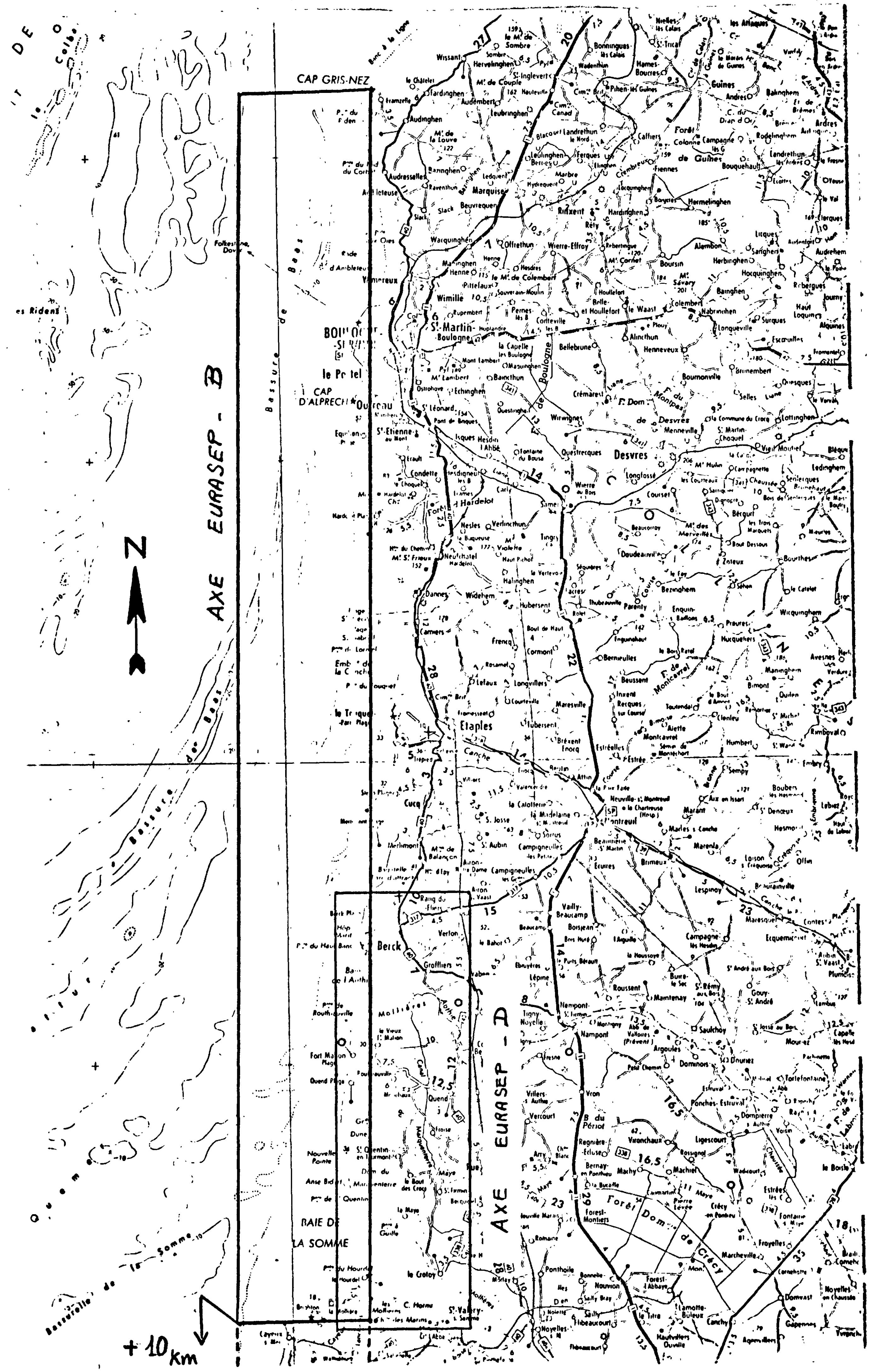
From 5000 metres altitude, one exposure will cover:

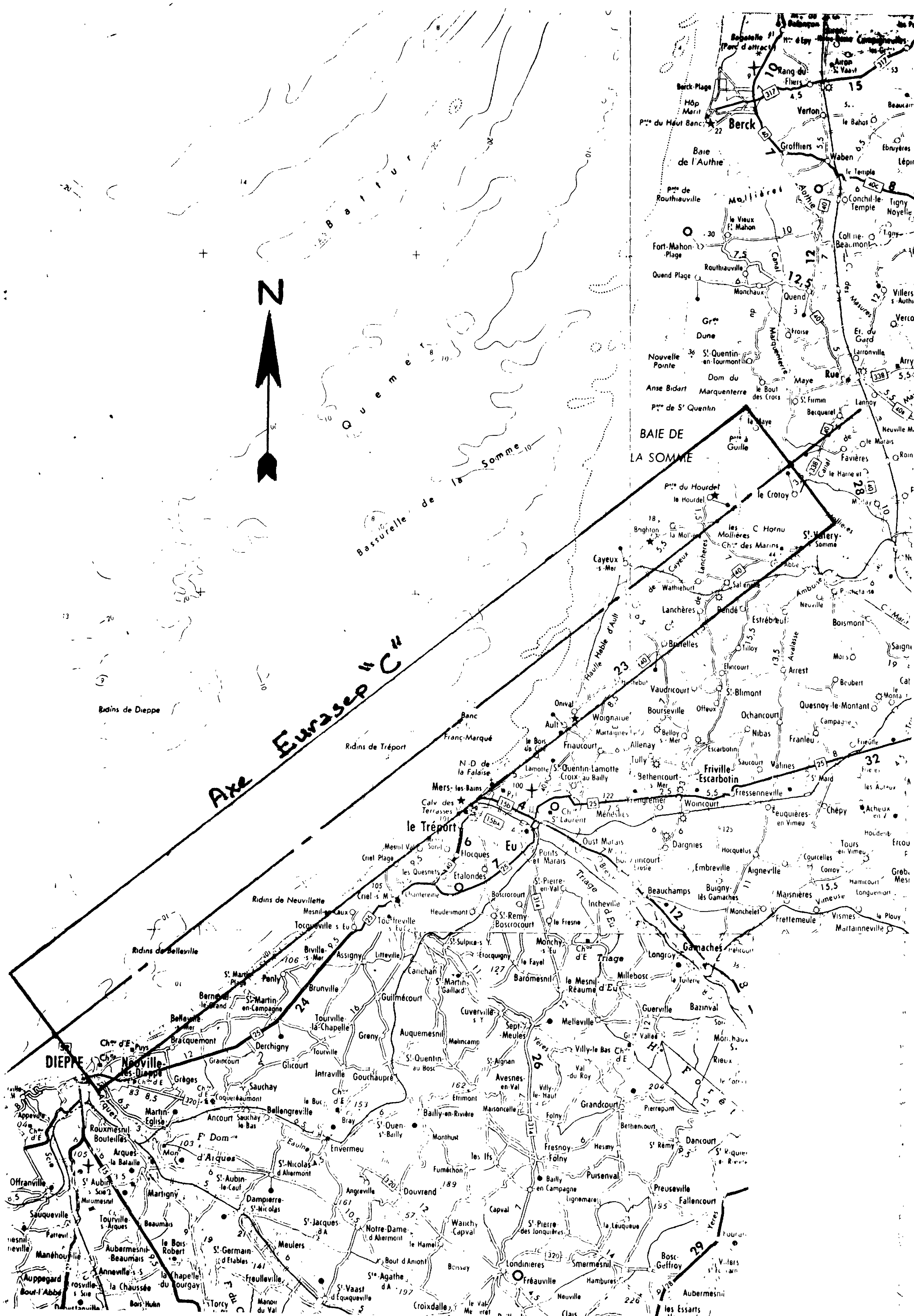
camera 1 : 7.9 x 7.9 km

camera 2 : 13.6 x 13.6 km



Axe Eurosep "A"
N
DUNKERQUE
CALAIS
BOULOGNE-SUR-MER
Gravelines
Bourbourg
Grand-Fort-Philippe
Loon-Plage
Grande-Synthe
St-Pol-sur-Mer
Coudekerque-Branche
Malo-les-Bains
Rosendael
Cappelle-la-Grande
Bergues
Marck
Coulogne
Guînes
Ardres
Audruicq
Watten
St-Omer
Arques
Longuenesse
Hazebrouck
Cassel
Wormhout
Marquise
Rinxent
Wimille
Wimereux
Le Portel
Outreau
St-Martin-Boulogne
Sangatte
CAP BLANC-NEZ
GRIS-NEZ
Wissant
Lumbres
Desvres
Forêt de Guînes
F. d'Eperlecques
F. Nat. de Tournehem
Ph de Walde
H! Fond de Gravelines
Banc du Snouw
Banc Breek
Ridens de la Rade

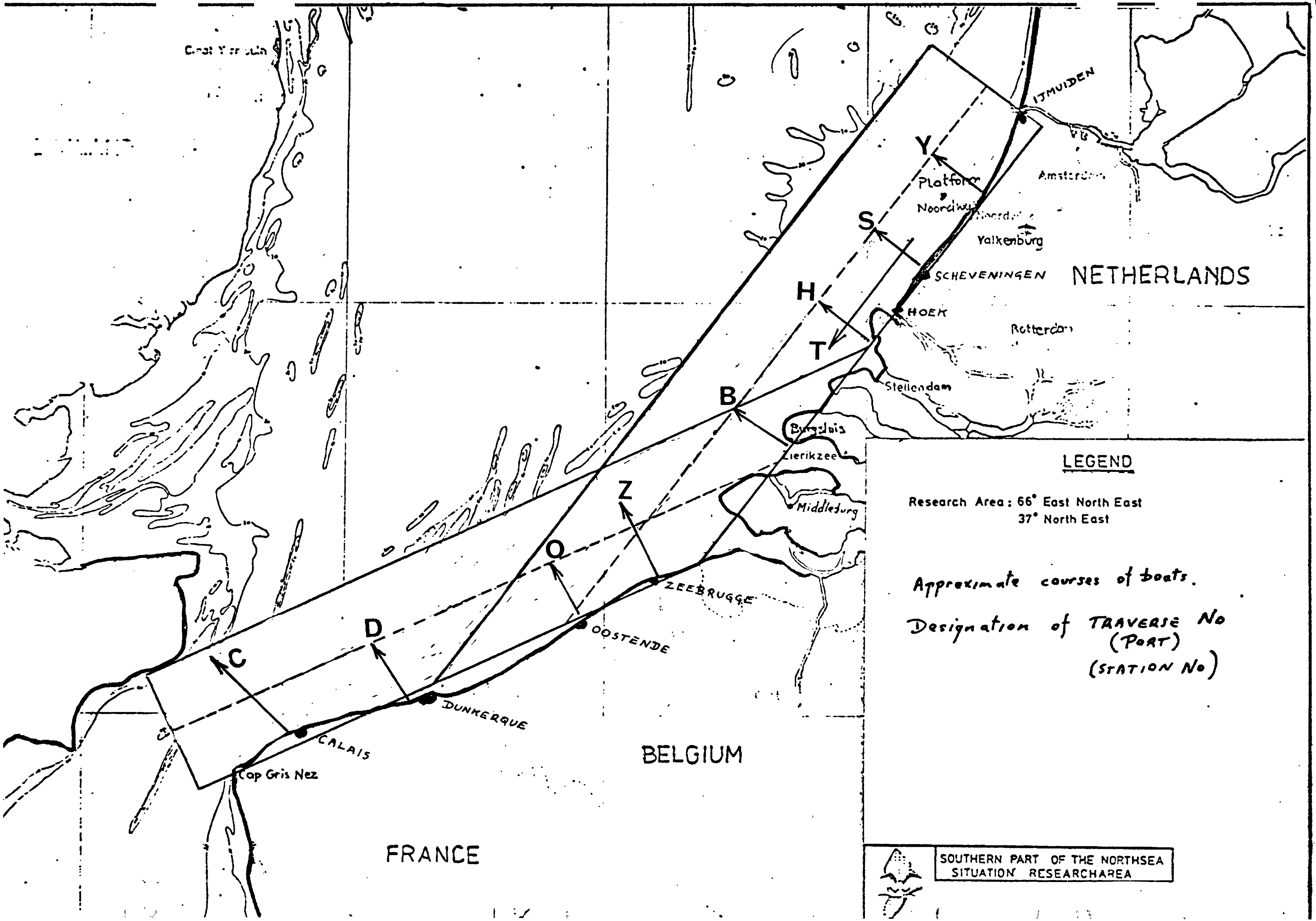

CAP GRIS-NEZ
AXE EURASEP - B
AXE EURASEP - D
N
+ 10 km
CAP D'ALPRECH
BAIE DE LA SOMME
Wissant
Marquise
Rinxent
Guînes
Forêt de Guînes
Ardres
Wimille
S. Martin-Boulogne
Desvres
F. Dom. de Desvres
Samer
Etaples
Canche
Montreuil
Berck
Le Crotoy
Quend
Rue
Forêt Dom. de Crécy
Crécy en Ponthieu
Nampont
Vron
Marquise
Colembert
Lumbres
Hucqueliers
Fruges
Hesdin
Campagne les Hesdin
Boulogne
Bassure de Baas
Folkestone, Dover
les Ridens
Fort Mahon Plage
Quend Plage
le Touquet Paris Plage
Cucq
Merlimont
Neufchâtel Hardelot
Dannes
Camiers
Lefaux
Outreau
le Portel



N
Axe Eurasep "C"
BAIE DE
LA SOMME
Baie
de l'Authie
Ridins de Dieppe
Ridins de Tréport
Ridins de Neuvillette
Ridins de Belleville
Bassurelle de la Somme
Quemer
Battur
Banc
Franc-Marqué
Berck
Berck-Plage
Rang-du-Fliers
Verton
Groffliers
Waben
Conchil-le-Temple
Fort-Mahon-Plage
Quend Plage
Routhiauville
Monchaux
Quend
Nouvelle Pointe
St-Quentin-en-Tourmont
Dom du Marquenterre
Rue
Le Crotoy
St-Valery-s-Somme
Pte du Hourdel
le Hourdel
Cayeux s-Mer
Lanchères
Pendé
Brutelles
Estréboeuf
Boismont
Vaudricourt
St-Blimont
Onival
Ault
Woignarue
Bourseville
Ochancourt
Nibas
Friaucourt
Allenay
Tully
Friville-Escarbotin
Mers-les-Bains
N-D de la Falaise
Calv des Terrasses
le Tréport
Eu
Hocques
Etalondes
Criel Plage
Criel-s-M
Mesnil-en-Caux
Tocqueville s Eu
Touffreville s Eu
St-Remy-Boscrocourt
Incheville
Gamaches
Longroy
Monchy s-Eu
Biville-s-Mer
Assigny
Penly
Brunville
St-Martin-Plage
Berneval-le-Grand
St-Martin-en-Campagne
Belleville-s-Mer
Bracquemont
Derchigny
Guilmécourt
Tourville-la-Chapelle
Greny
Auquemesnil
Cuverville
Sept-Meules
Melleville
Villy-le Bas
DIEPPE
Neuville-lès-Dieppe
Graincourt
Glicourt
Grèges
Sauchay
Intraville
Gouchaupré
Martin-Eglise
Ancourt
Bellengreville
Envermeu
Rouxmesnil-Bouteilles
Arques-la Bataille
Ft Dom d'Arques
Offranville
St Aubin
Sauqueville
Martigny
Dampierre-St-Nicolas
St-Nicolas d'Aliermont
Douvrend
St-Jacques d'A
Notre-Dame-d'Aliermont
Meulers
St-Germain-d'Etables
Freulleville
St-Vaast d'Equiqueville
Croixdalle
Londinières
Fréauville
Smermesnil
Grandcourt
Fresnoy-Folny
Puisenval
Bailly en Campagne
Preuseville
Fallencourt
Bosc-Geffroy
Aubermesnil
les Essarts
Baromesnil
le Mesnil-Réaume
Millebosc
Guerville
Bazinval
Dargnies
Embreville
Aigneville
Beauchamps
Buigny-lès-Gamaches
Woincourt
Fressenneville
Feuquières-en Vimeu
Chépy
Valines
Franleu
Quesnoy-le-Montant
Arrest
Marsnières
Frettemeule
Vismes

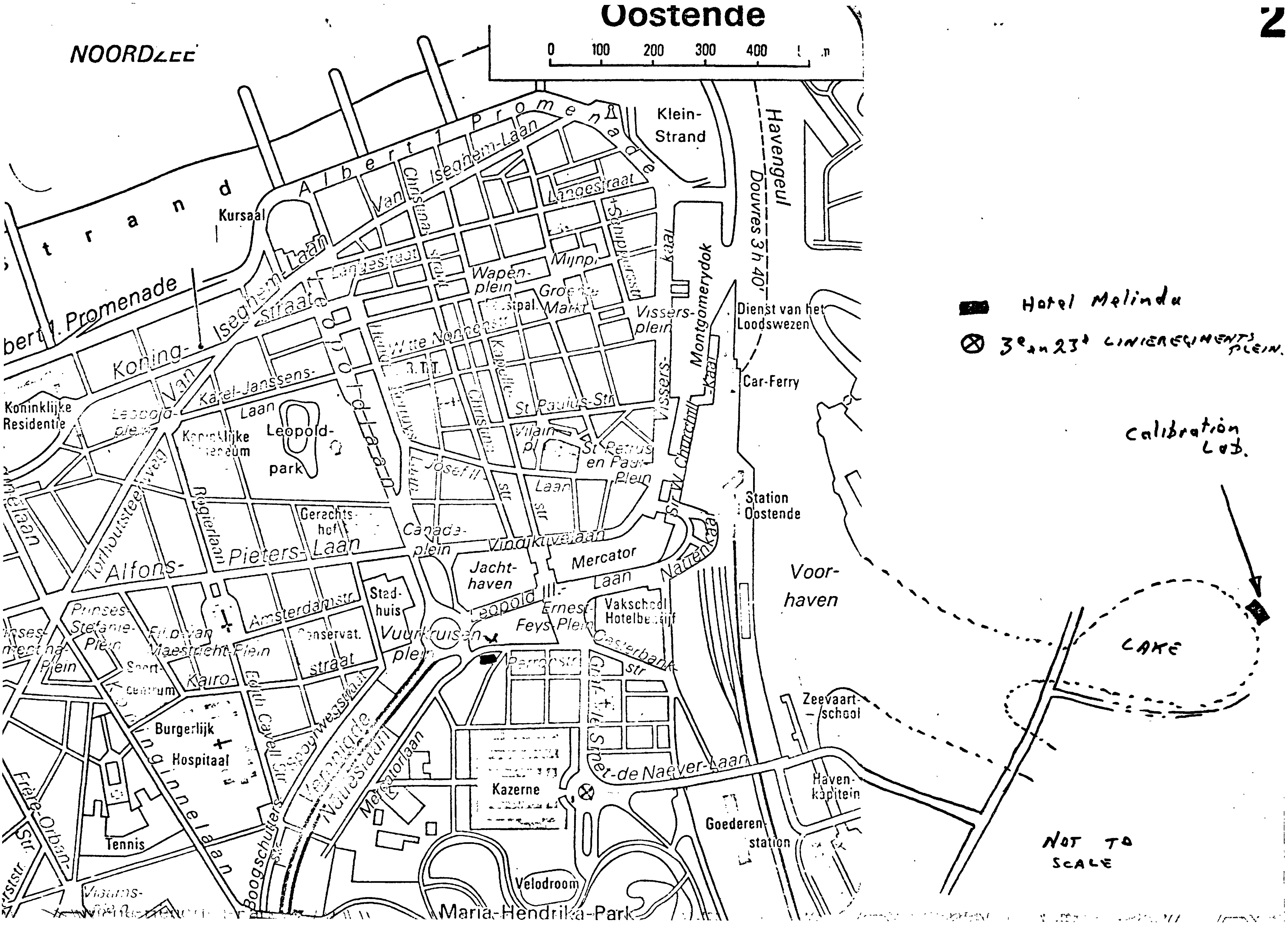
APPENDIX III

The complete set of handouts to all sea truth teams



NETHERLANDS
BELGIUM
FRANCE
IJMUIDEN
Amsterdam
Platform
Noordwijk
Valkenburg
SCHEVENINGEN
HOEK
Rotterdam
Stellendam
Burghsluis
Zierikzee
Middelburg
ZEEBRUGGE
OOSTENDE
DUNKERQUE
CALAIS
Cap Gris Nez
Y
S
H
T
B
Z
O
D
C
LEGEND
Research Area: 66° East North East
37° North East
Approximate courses of boats.
Designation of TRAVERSE No
(PORT)
(STATION No)
SOUTHERN PART OF THE NORTHSEA
SITUATION RESEARCHAREA

2


Oostende
0 100 200 300 400
NOORDZEE
Strand
Kursaal
Albert 1 Promenade
Klein-Strand
Havengeul
Douvres 3 h 40'
Dienst van het Loodswezen
Car-Ferry
Station Oostende
Voorhaven
Montgomerydok
Vissers-kaai
Vissersplein
Langestraat
Schipperstr
Mijnpl.
Wapenplein
GroenTe Markt
Christinastraat
Van Iseghem-Laan
Iseghem-Straat
Koning-
Van
Karel-Janssens-Laan
Koninklijke Residentie
Leopoldplein
Leopold-park
Leopoldlaan
Koninklijke Atheneum
Kapellestr
St Paulus-Str
St Petrus en Paul-Plein
Vilainpl.
Josef II-str
Canadaplein
Vindiktivelaan
Jachthaven
Mercator
Leopold III-Laan
Natiënkaai
Sir W. Churchill-Kaai
Ernest-Feys-Plein
Vakschool Hotelbedrijf
Oesterbank str
Gerechtshof
Pieters-Laan
Alfons-
Torhoutsteenweg
Rogierlaan
Stadhuis
Vuurkruisenplein
Amsterdamstr.
Conservat.straat
Fil. van Vlaestricht-Plein
Kairo-
Sportcentrum
Prinses-Stefanie-Plein
Burgerlijk Hospitaal
Koninginnelaan
Edith Cavell Str
Boogschutters-str
Nieuwpoortsesteenweg
Nationdam
Mercatorlaan
Graaf de Smet-de Naeyer-Laan
Kazerne
Velodroom
Maria-Hendrika-Park
Zeevaartschool
Havenkapitein
Goederenstation
Tennis
Frère-Orban-Str.
Hotel Melinda
3e en 23e LINIEREGIMENTS PLEIN.
Calibration Lot.
LAKE
NOT TO SCALE

EURASEP NIMBUS G PROJECT

OCS experiment '77

Calibration procedure Ostend - June 13 - 16

Mon. - June 13:

Arrival at Melinda Hotel and informal gathering in evening in the hotel conference room.

Tue. - June 14:

Assembling and trial run of all equipment at the "calibration laboratory" (See map (2)).

A teach-in will be held during the evening the timing of which will be arranged during the day.

Wed. - June 15:

Calibration of instruments at the "calibration laboratory".

600 l (A) of a nearshore sample of water and another 600 l (B) of an offshore sample will be taken early by the Belgian research vessel.

Pumped sample readings will be taken from a container holding:

a) 400 l of A

b) 400 l of B

c) 200 l of A + 200 l of B.

Samples for a) and b) and c) will be taken to the Hague for analysis by the same company that will perform the main analysis contract. Results of the calibration analysis will be "phoned/radioed to participants so that their calibration charts (sheets 4, 5) can be completed.

In addition the sampling delay time and temperature rise (if measurable) through the sampling system will be determined. It is therefore essential that all piping that will be used in the boats is incorporated into the calibration run.

4

EURASEP NIMBUS G. PROJECT

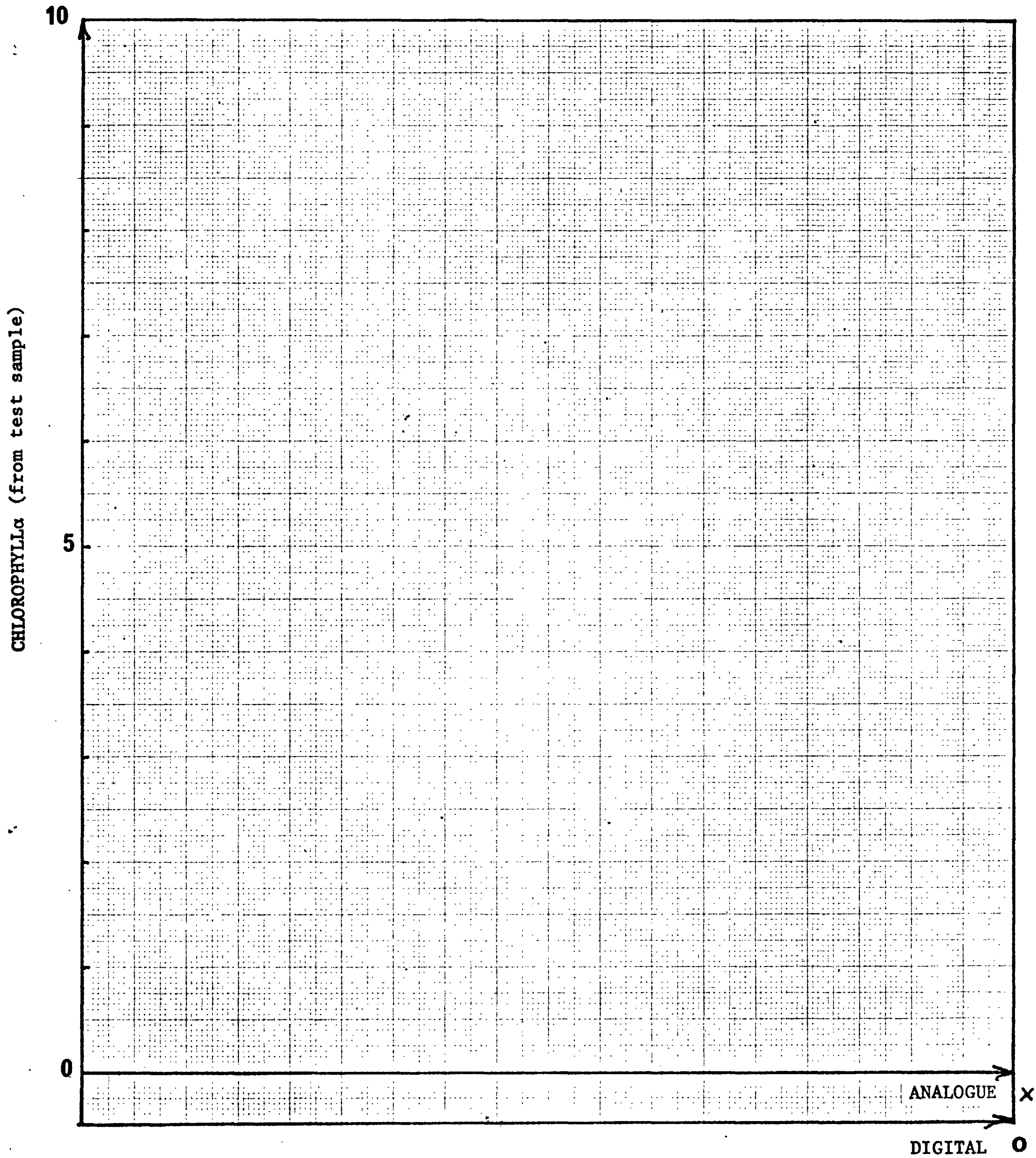
O.C.S. EXPERIMENT '77

Sea Truth Data

CALIBRATION FOR CHLOROPHYLLα

STATION No. GROUP LEADER DATE

mg/m³ INSTRUMENT WATER TEMP.



INSTRUMENT READING

EURASEP NIMBUS G. PROJECT

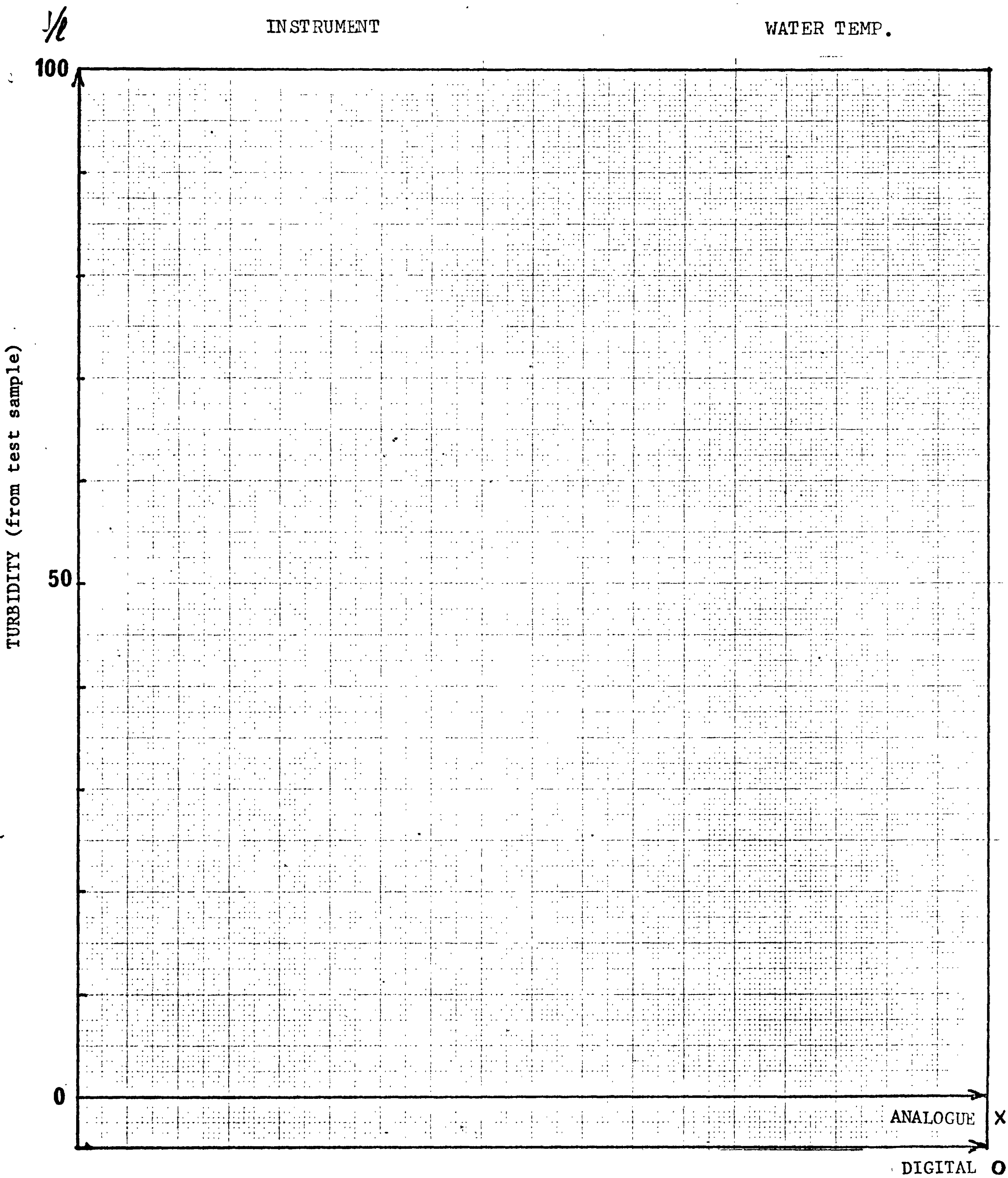
O.C.S. EXPERIMENT '77

Sea Truth Data

CALIBRATION FOR 'TURBIDITY'

STATION No. GROUP LEADER DATE

INSTRUMENT WATER TEMP.



INSTRUMENT READING

EURASEP NIMBUS G. PROJECT

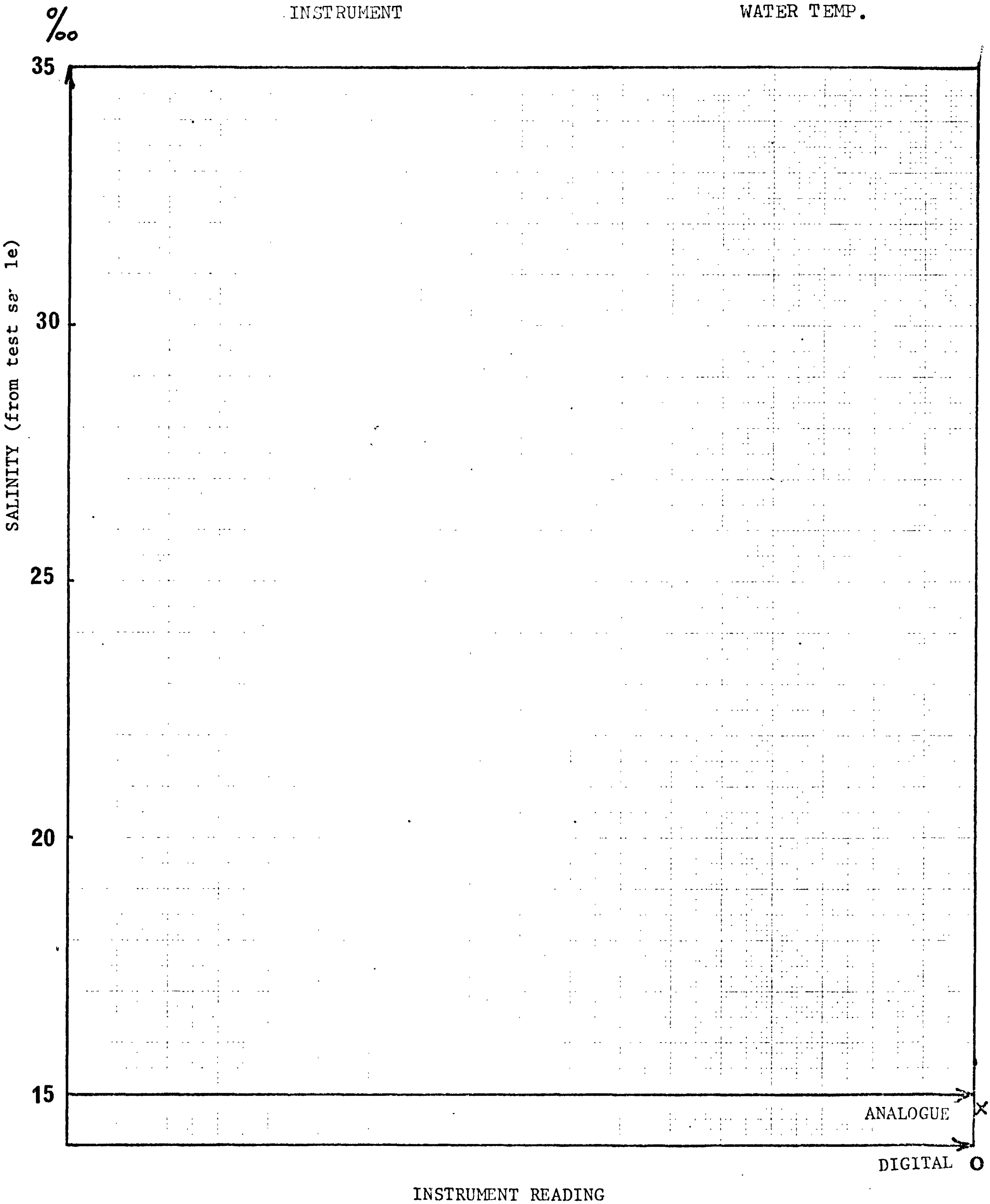
O.C.S. EXPERIMENT '77

Sea Truth Data

CALIBRATION FOR SALINITY

STATION No. GROUP LEADER DATE

INSTRUMENT WATER TEMP.



EURASEP NIMBUS G. PROJECT

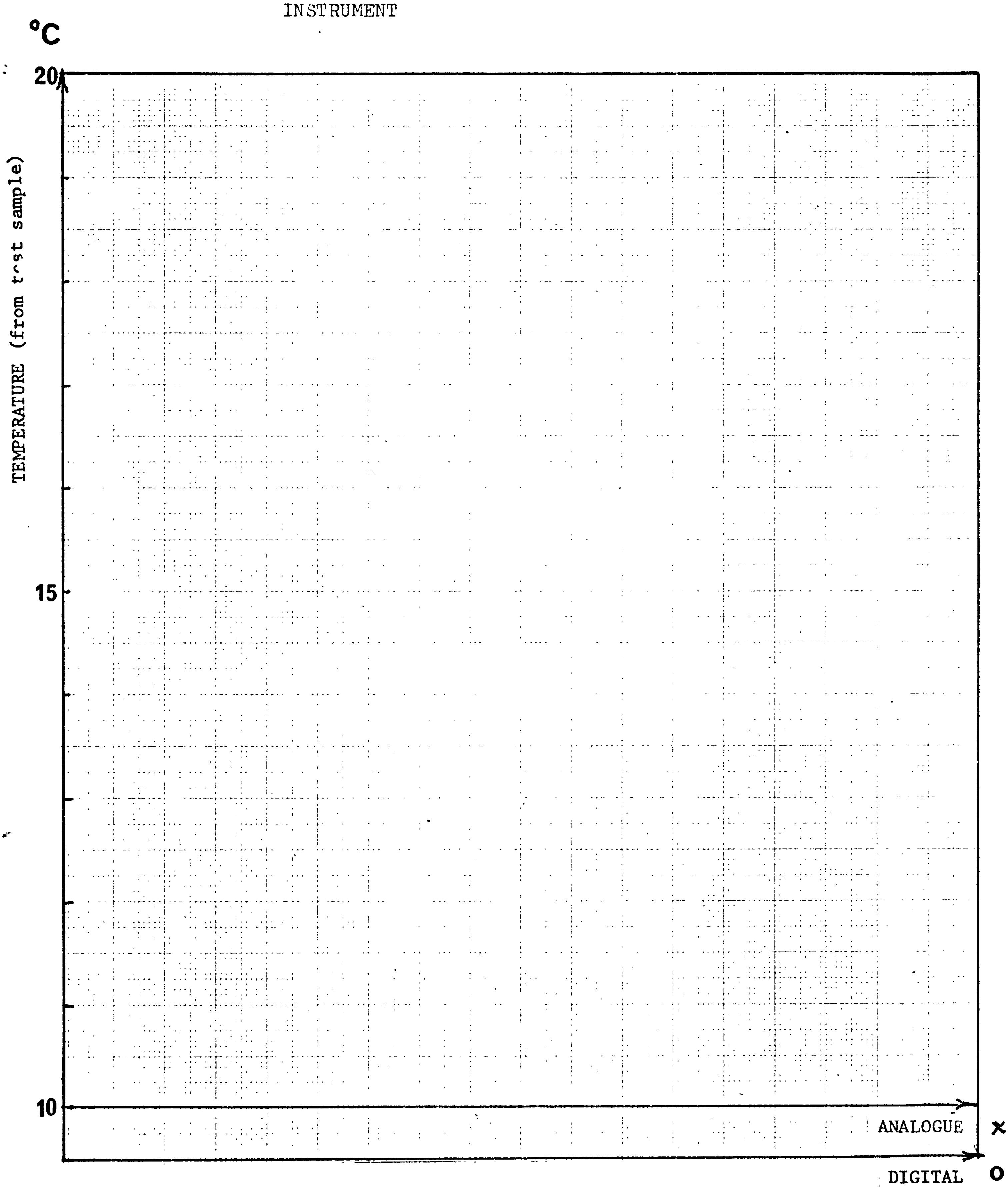
O.C.S. EXPERIMENT '77

Sea Truth Data

CALIBRATION FOR TEMPERATURE

STATION No.   GROUP LEADER   DATE

INSTRUMENT



INSTRUMENT READING

EUROSEP NIMBUS G PROJECT

OCS experiment '77

General timing for sea truth missions

Each day from June 20th - July 3rd inc. a GO/NO GO signal will be communicated at 10.00 hours.

A confirmation, or otherwise, of the signal will be communicated at 11.50 hours.

The Northern flight is due to start over IJmuiden at 13.00 hours and will be monitored by boats Y, S, H, T, B and Z.

These boats must be on station at the start of their traverse at 11.50 hours, if a GO signal has been received at 10.00 hours. If the 11.50 signal is also for GO they will immediately commence their sampling traverse and follow their individual time schedules.

The Southern flight leg is due to start over the Middelburg at 14.30 hours and will be monitored by boats Z, O, D and C.

With the exception of Z and C, these boats must be on station and ready to start their traverses by 13.00 hours. (They will have received both the 10.00 and the 11.50 signals). These boats will commence their sampling traverses at 13.00 and follow their individual time schedules.

EURASEP NIMBUS G PROJECT

OCS experiment '77

Sea truth sampling traverse and timing details

Port   Traverse code

Traverse line

Start   Finish

Decca track

1) Traverse start time

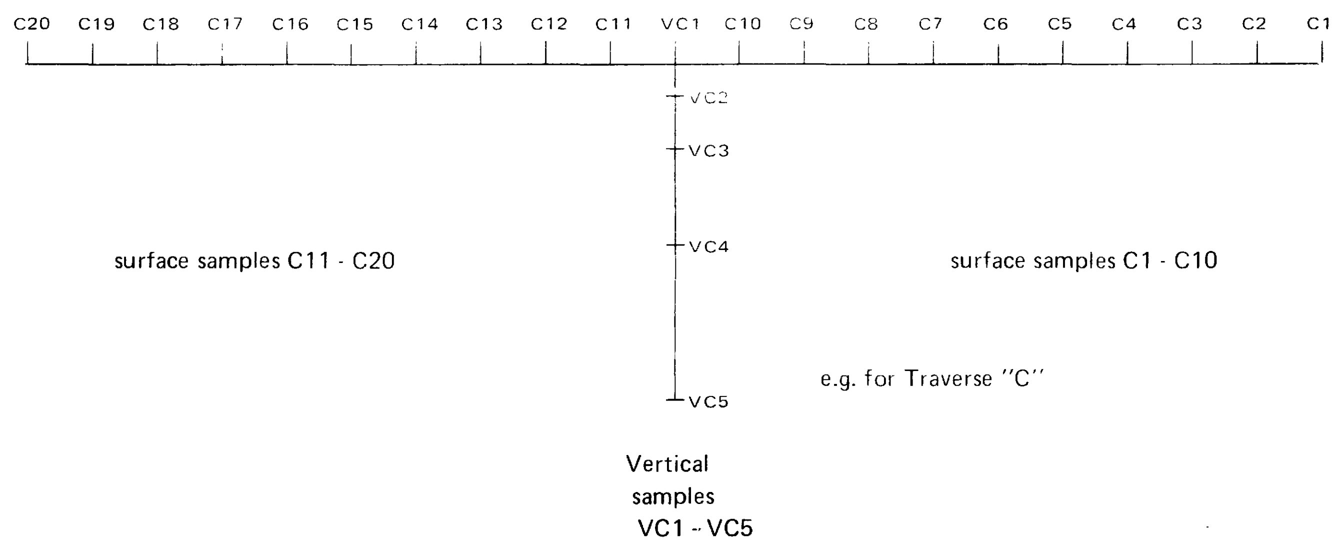
2) Boat to proceed at 5 knots (or 5 nm) until   , continuous surface sampling will be used. In addition 10 equally spaced sets of discreet samples will be drawn from the surface sampling equipment (see sheet 10).

3) At   the boat is to be stationary (not anchored, c.f. teach-in notes by Picard). Discreet vertical profile samples, using the sampling bottle will be taken simultaneously with Secchi disc observations. Samples will be taken from:

1. surface (pumped)
2. 1 m depth (sampler)
3. 3 m depth (sampler)*
4. Secchi disc depth
5. 2.5 x Secchi disc depth.

* This depth to be adjusted if it is too close to the Secchi disc depth.

STANDARD FORMAT FOR STATION AND SAMPLE NUMBERING



4) At   the boat should continue on its course to the end of its track (1 hour approximately) sampling as in (2).

5) On completion the boat will return to port.

EURASEP NIMBUS G PROJECT

OCS experiment '77

Sea truth sampling procedure

1) Continuous sampling

It has been decided to take continuous samples of Chlorophyll alpha, turbidity, salinity and temperature, over the whole traverse, from the top 10 - 15 cm of water, using a towed floating sampler and a pumping system. The water is to be pumped through the various measuring instruments adopted as appropriate. Digital, analogue, or manual data recording is used in conjunction with the discreet sampling.

Continuous sampling is being used as a measure of parameter gradients between the more accurately determined discreet samples.

2. Discreet sampling

Water samples will be taken periodically (sheet 9) from the pumped sampling apparatus and from the vertical profile for discreet sample analysis. A 5 l sample should be taken, and while still agitated divided into:

a)	2 l for chlorophyll analysis
b)	2 l for sediment analysis
c)	250 ml for plankton analysis
d)	100 ml for yellow substance analysis

a) The chlorophyll sample should be immediately filtered through the supplied glass-fibre filters until filter blocking occurs. The filter should first be covered with 2 ml of a 1% solution of $MgCO_3$.

(cont.)

The volume of filtrate used should be recorded, the filter removed and packed in foil and labelled. This sample must be kept cool or frozen. At the latest it must be frozen on return to port.

b) This sample is to be frozen as soon as possible after return to port.

c) The plankton sample should be preserved by having added an amount of about 10 - 20 ml of 40% formaldehyde.

d) No treatment is necessary.

All samples will be stored until the end of the exercise when they will be collected by a special vehicle.

3) Sample labelling

Great care must be used in making sure that all samples are labelled accurately with the traverse code and station number (sheet 9). This station number must correspond to that used on sheets 11, 12, 13.

Standard format for station and sample numbering: see enclosed figure.

4) Position logging and timing

Sheet 11 should be used for this.

The Decca position (start and finish) of all discreet sampling "points" should be noted, and the period of sampling marked on the continuous sampling output.

In addition, intermediate positions may be taken with correspondingly marked continuous sampling output.

EURASEP NIMBUS G PROJECT

OCS experiment '77

Instruction for use of the Munsell color scale

1) Determine the Secchi disc depth at the sunny side of the boat.
2) Lower the Secchi disc to the half of the Secchi disc depth.
3) Select the color on the Munsell color scale that matches with the color of the Secchi disc at half Secchi disc depth.

Secchi disc depth .... cm

Half Secchi disc depth .... cm

Munsell color code......................

Instruction for use of the optical filters Wratten 98, 99, 29

Lower the Secchi disc while looking at it through the blue filter (98). Determine the depth at which the Secchi disc becomes extinct and note this depth.

Repeat the procedure with the green filter (99) and the red filter (29).

DEPTH

blue 98 cm	green 99 cm	red 29 cm

EUR/C-IS/31/78.e

EURASEP NIMBUS G. PROJECT

O.C.S. EXPERIMENT '77

NAVIGATION LOG Sea Truth Data

SHIP: LOCATION: TEAM LEADER SHEET NO. OF

DATE:

TIME OF HIGH WATER

1	2	3	4	5	6	7	8	9	10
POSITION TATION No	TIME G.M.T.	DECCA POSITION			WIND SPEED + DIRECTION	WAVE HEIGHT AND PERIOD	VISI- BILITY	CLOUDS	COMMENTS

12

URASEP NIMBUS G. PROJECT

O.C.S. EXPERIMENT '77

LOG OF SURFACE PROFILES   Sea Truth Data

TEAM LEADER   SHEET NO.   OF

EQUIPMENT: DATE

SHIP:

ON TRAVERSE

ANALOGUE X
DIGITAL O

SECCHI DISC DEPTH   m   x 2.5 = PROFILE DEPTH   m

	TIME G.M.T.	WATER SAMPLE NO.	SALINITY	TEMP.	TURB'TY	CHLORO -PHYLL	SOUNDED WATER DEPTH		COMMENTS

EURASEP NIMBUS G. PROJECT

O.C.S. EXPERIMENT '77

13

LOG OF STATIONARY VERTICAL PROFILE Sea Truth Data

STATION NO. TEAM LEADER SHEET NO. OF

SHIP: EQUIPMENT: DATE

ON TRAVERSE

ANALOGUE X
DIGITAL 0

SECCHI DISC DEPTH m x 2.5 = PROFILE DEPTH m

DEPTH BELOW SURFACE OF SAMPLE	TIME G.M.T.	WATER SAMPLE NO.	SALINITY	TEMP.	TURB'TY	CHLORO -PHYLL	SOUNDED WATER DEPTH	OBSERVED SECCHI COLOUR	COMMENTS

O.C.S.EXPERIMENT '77

Enclosed you will find data sheets for plotting your continuous/intermittent sampling of chlorophyll, turbidity, temperature, and salinity, for the horizontal and vertical profiles.

Would you please:-

a) trim the sheets and fasten them together into a strip

b) mark the position of the discreet samples

c) plot tour instrument readings without calibration, including all variations except minor variations (see example sheet)

d) in your plotting allow for the time- distance delay caused by the pumping system

e) state the delay distance used

f) return one set of the completed sheets together with all the data taken on the experiment (express) to:-

B.M.Sørensen
C.C.R.
EURATOM
2100 ISPRA (Va)
ITALY

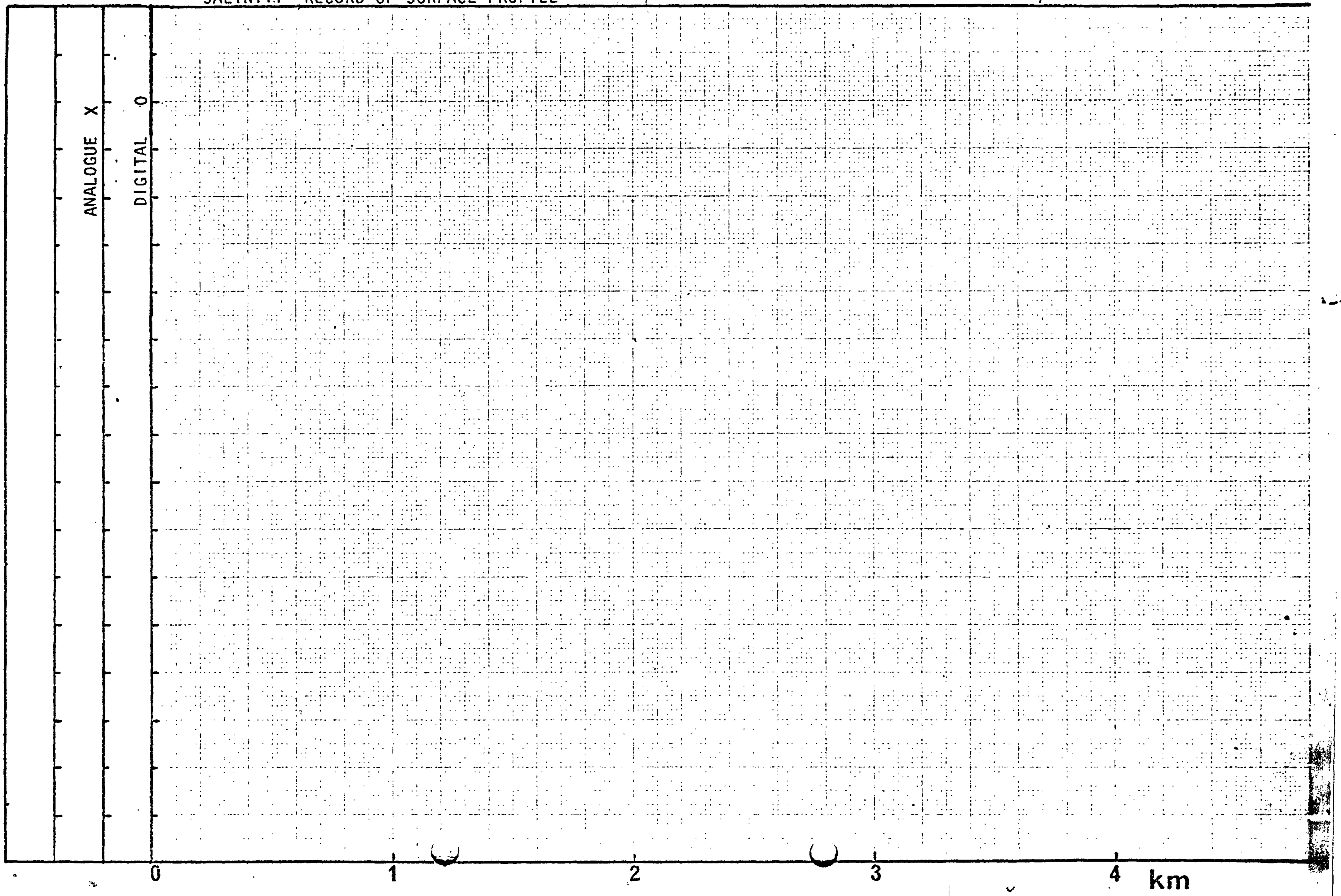
The results of the discreet sample analysis will be added at Ispra.

These results will also be separately sent to participants.

EURASEP NIMBUS G PROJECT O.C.S.EXPERIMENT '77 SEA TRUTH DATA

Traver-- line Team leader Survey d

SALINITY -RECORD OF SURFACE PROFILE Delay distance



EURASEP NIMBUS G PROJECT O.C.S.EXPERIMENT '77 SEA TRUTH DATA

Traverse line Team leader Survey date

TURBIDITY-RECORD OF SURFACE PROFILE Delay distance

ANALOGUE X

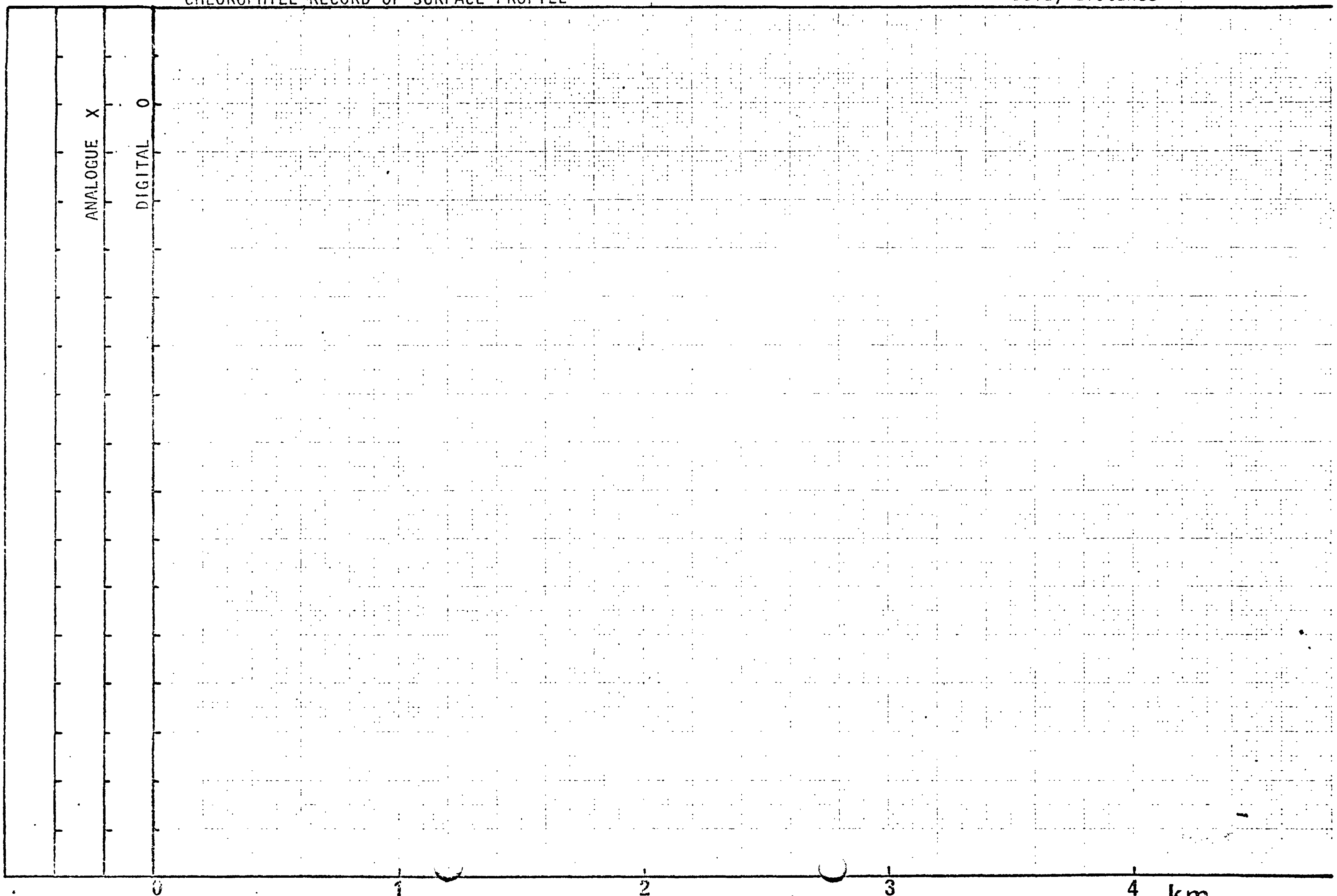
DIGITAL 0

0 1 2 km 3 4 km

EURASEP NIMBUS G PROJECT O.C.S.EXPERIMENT '77 SEA TRUTH DATA

Traverse line Team leader Survey e

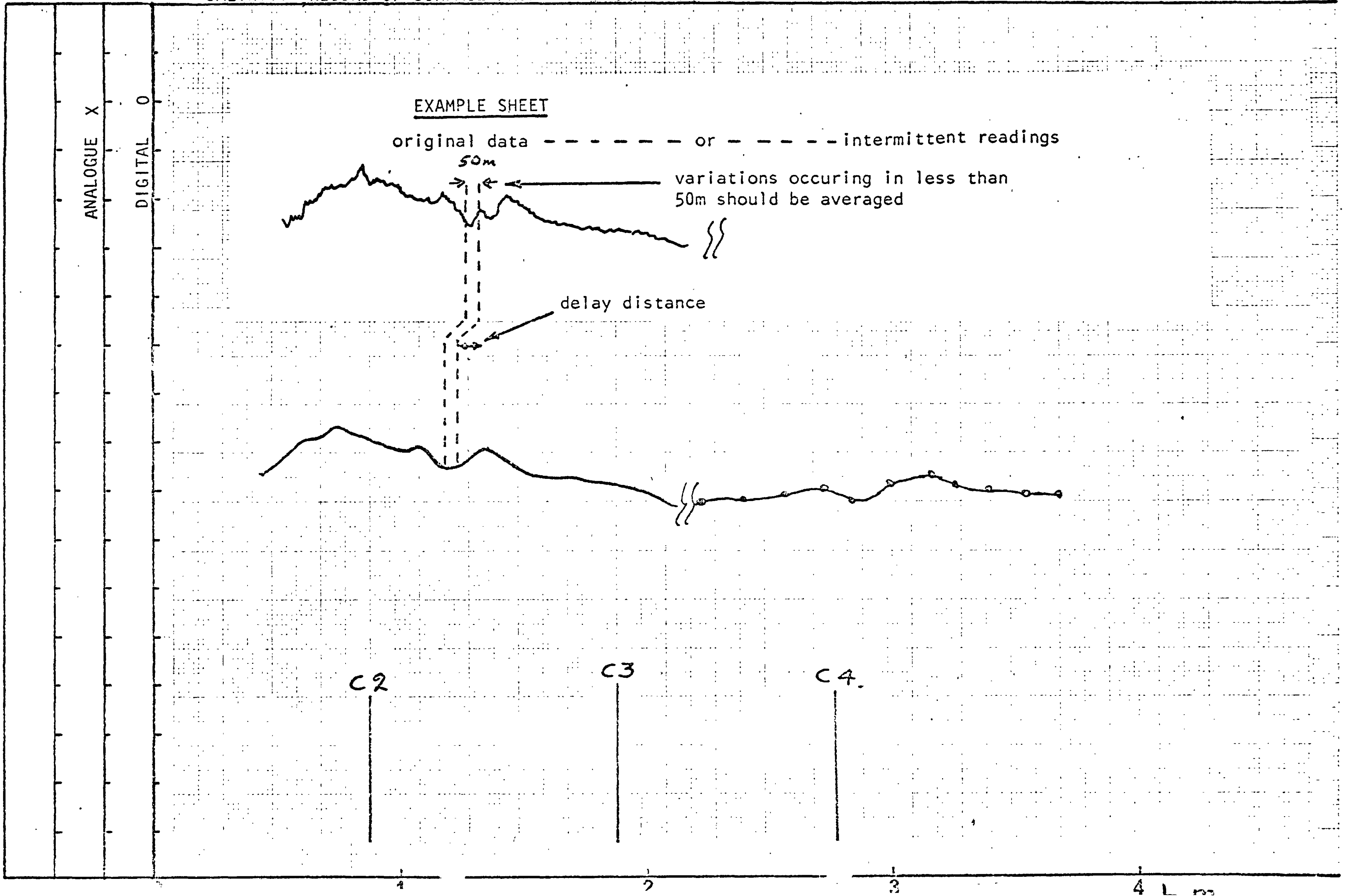
CHLOROPHYLL-RECORD OF SURFACE PROFILE Delay distance



EURASEP NIMBUS G PROJECT O.C.S.EXPERIMENT '77 SEA TRUTH DATA

Traverse line Team leader Survey date

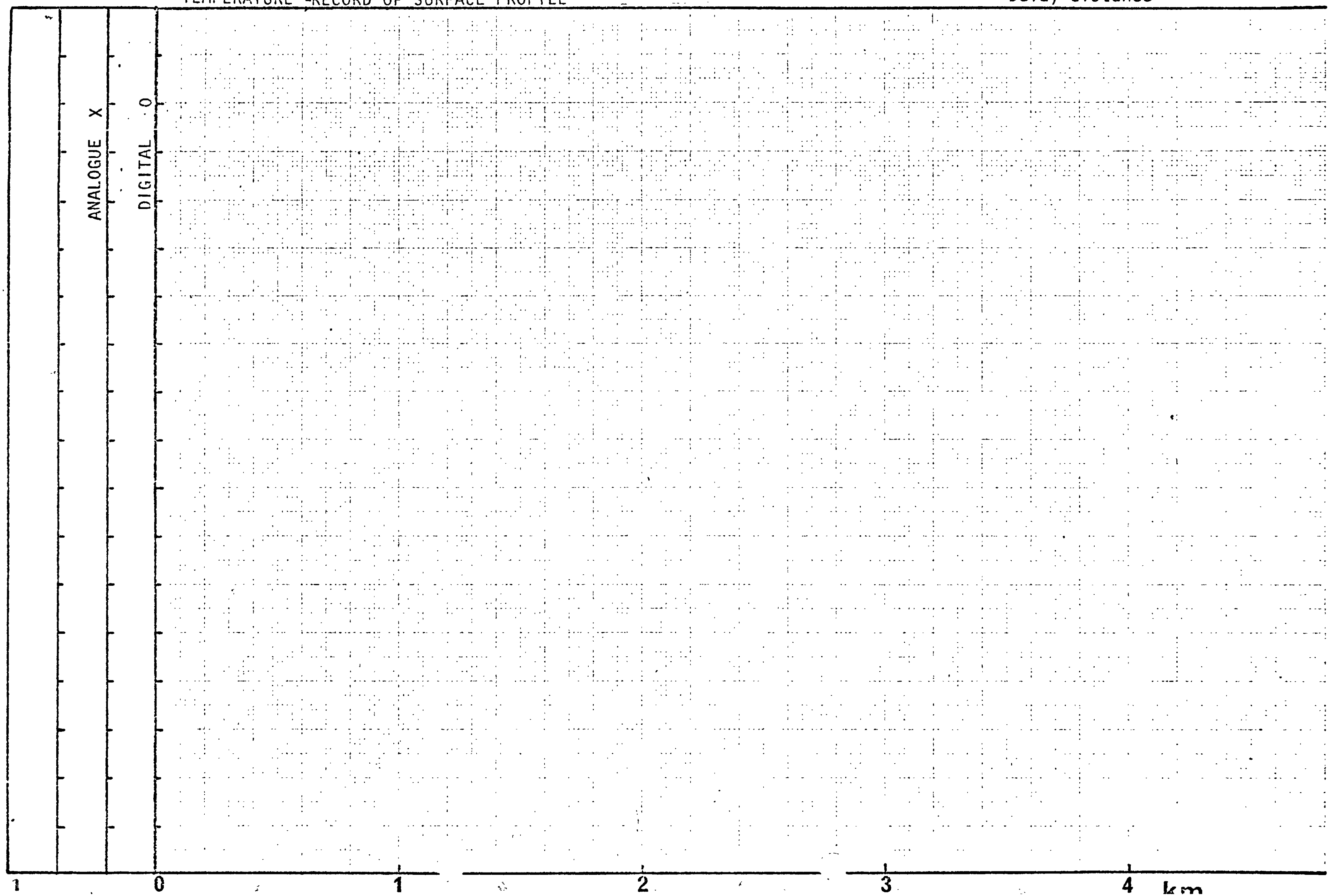
SALINITY -RECORD OF SURFACE PROFILE Delay distance



EURASEP NIMBUS G PROJECT O.C.S.EXPERIMENT '77 SEA TRUTH DATA

Traverse line Team leader Survey date

TEMPERATURE -RECORD OF SURFACE PROFILE Delay distance



OCS experiment '77

Enclosed you will find data sheets for plotting your continuous/ intermittent sampling of chlorophyll, turbidity, temperature and salinity, for the horizontal and vertical profiles.

Would you please:

a) trim the sheets and fasten them together into a strip;
b) mark the position of the discreet samples;
c) plot your instrument readings without calibration, including all variations except minor variations (see example sheet);
d) in your plotting allow for the time- distance delay caused by the pumping system;
e) state the delay distance used;
f) return one set of the completed sheets together with all the data taken on the experiment (express) to:

B. M. Sørensen
C. C. R.
EURATOM
2100 Ispra (Va)
Italy

The results of the discreet sample analysis will be added at Ispra.

These results will also be separately sent to participants.

APPENDIX IV

Mission summary from the experiment

27/6/77	Dutch coast	Belgian coast	French coast
Mystere/OCS + metric camera	X		
Dornier/M^2S + others			
Sea truth bessels	5		
continuous measurement	X		
sampling	X		
Secchi disc/filters/Munsellcard	X		
water samples (V)	X		
quantameter			
colorimeter			
18-ch radiometer			
Atmospheric measurements			
Noordwijk	X		
Goeree	X		
Volkenburg	X		
Burghsluis	X		
Cap Gris Nez			X
Sea condition measurements			
Noordwijk	X		
Goeree	X		
Dunkerque			X
Saudeltre lightship (Cap Gris Nez)			X
buoys	X		

29/6/77	Dutch coast	Belgian coast	French coast
Mystere/OCS + metric camera		X	
Dornier/M^2S + others		X	
Sea truth vessels			
continuous measurement	some	X	X
sampling	3	X	X
Secchi disc/filters/ Munsellcard	some	X	X
water samples (V)		X	X
quantameter		X	
colorimeter		X	
18-ch radiometer		X	
Atmospheric measurements			
Noordwijk	X		
Goeree	X		
Valkenburg	X		
Burghsluis	X		
Cap Gris Nez			X
Sea condition measurements			
Noordwijk	X		
Goeree	X		
Dunkerque			X
Saudeltre lightship (Cap Gris Nez)			X
buoys	X		

3/7/77	Dutch coast	Belgian coast	French coast
M = Morning A = Afternoon			
Mystere/OCS + metric camera	M	M + A	M + A
Dornier/M^2S + others			
Sea truth vessels	M	M + A	M
continuous measurement	X	X	X
sampling	X	X	X
Secchi disc/filters/ Munsellcard	X	X	X
water samples (V)	X	X	X
quantameter		X	
colorimeter		X	
18-ch radiometer		X	
Atmospheric measurements			
Noordwijk	X		
Goeree	X		
Valkenburg	X		
Burghsluis	X		
Cap Gris Nez			X
Sea condition measurements			
Noordwijk	X		
Goeree	X		
Dunkerque		X	
Sadeltre lightship (Cap Gris Nez)			X
buoys	X		

APPENDIX V

Lay-out of Remote Sensing Control Centre

REMOTE SENSING CONTROL CENTRE

Operational Notes

I. The Rooms

a) Double glazing and air condition to keep out exterior noise.

b) Adequate space for charts, plans and notes on tables and walls.

c) Comfort over long operational periods (also outside normal working hours) necessary, such as refreshment facilities.

II. Communication Facilities

a) VHF radio (118 - 136 MHz) for air-ground communication.

b) MW/VHF radio for land - sea communication.

c) 5 - 8 telephones, one of which is connected to an audiorecorder.

d) Telex in separate room.

III. Personnel

Minimum 2, maximum 4 persons speaking several languages and qualified to operate all equipment in the control centre.

IV. Operation

a) No access to the centre for persons without authorization.

b) If possible, make one language official and avoid mixing languages when using phones and radios.

c) All messages - coming and going - should be filed or fixed to walls by clips or magnetic strips.

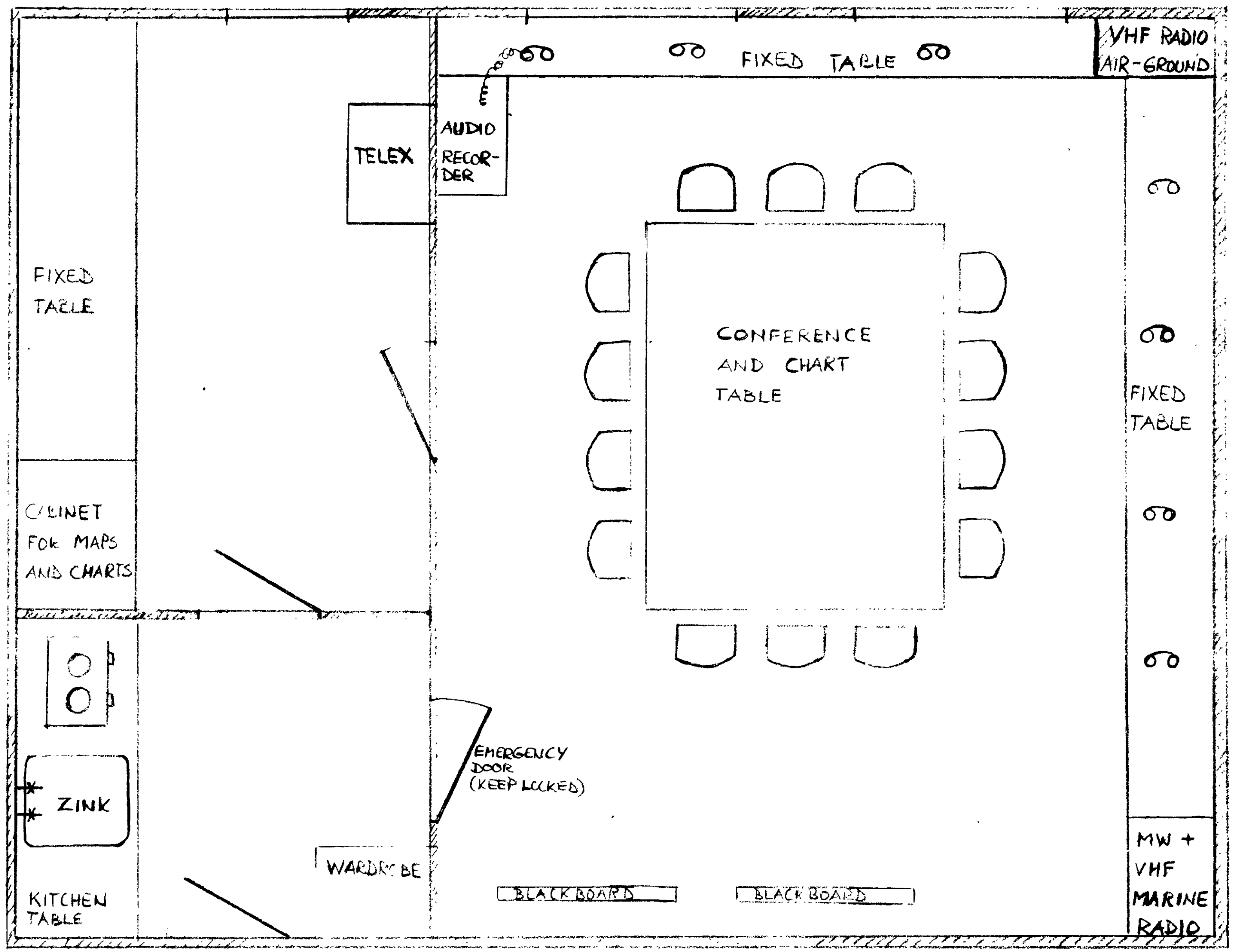
d) Time dependent information should be kept up to date, and old or erroneous information should be kept in special files out of sight.

V. Other

a) An audio tape recorder to record special messages or discussions may be advantageous.

b) Music should be abandoned in the control room.

J.A. CHARLTON B.M. SØRENSEN



NOT IN SCALE

PROPOSED DESIGN OF REMOTE SENSING CONTROL CENTRE

APPENDIX VI

Report from the Weather Forecasting Service

WEATHER FORECASTING

Sea and Storm Service Specialists Ltd. (SSSS), who have a weather forecasting office within Dundee University campus, telexed specialised forecasts to EURASEP Control each day of the trial. The meteorological task was to forecast the likelihood of the Ocean Color Scanners "seeing" the ground from the two flight levels of 4000 m and 12000 m. In order to achieve the purpose of the trial, less than one-third cloud cover was necessary together with an absence of surface or low level fog, mist, or thick haze. Unfortunately, in the narrow waters between SE England and the Low Countries over which the flights were conducted, the atmospheric conditions which favour an absence of cloud usually produce poor or only moderate surface visibility because of sea fog and/or industrial haze. A further restriction was the requirement that there should be no white caps which means a surface wind over the sea of less than about 8 knots (9mph).

The technical problem of forecasting a favourable combination of circumstances was tackled by the orthodox method of synoptic chart analysis which indicates the location and intensity of pressure systems, such as anticyclones and depressions, the position and likely movement of fronts with their associated cloud belts, and the general characteristics of the air masses affecting western Europe. In addition, an indispensible aid was provided by the photographs obtained from weather satellite passes over the eastern North Atlantic and the Continent. These photographs reveal the extent and type of cloud over a wide area centered on the satellite's path. It will be evident that such pictures are a powerful tool in the hands of the meteorologist enabling him to assess the intensity, direction and speed of movement of a particular system from successive satellite passes.

Satellite data was provided by the Department of Electrical Engineering and Electronics, Dundee University, in the form of low resolution scanning radiometer IR and vis. images covering large areas of Europe and the Atlantic. In addition, very high resolution radiometer images of the trial area were provided, showing the cloud cover in finer detail. The acquisition of these satellite pictures by the Electronics Department Laboratory of Dundee University has provided (SSSS) with the means to improve and refine their forecast information for North Sea oil operations. However, to return to the matter. The absence of traditional visual observations of meteorological variables over the sea, which is a major difficulty in all maritime forecasting problems, means that the cloud information obtained by satellite is essential for the success of operations of this nature if time, effort and money are not to be wasted on abortive sorties.

The routine followed during the trial required a forecast to be prepared in the forenoon for passing to the EURASEP Control Centre near the Hague by 0930 GMT. Communication was by telex but frequent telephone discussions were held to enlarge upon the forecast or to deal with other relevant operational matters. Should this first forecast be favourable, the timing allowed the participating ships and aircrafts to be given notice to come to the state or operational readiness. After the first usable satellite pass during the morning, there is another approximately two hours later which in this case enabled earlier deductions to be confirmed or denied. On the basis of this later information further advice was passed either by telex or telephone and this enabled the Centre to decide whether to proceed or cancel the day's operation.

The trial period extended from 20th June to 3rd July. At the outset atmospheric conditions over the southern North Sea were dominated by an anticyclone to the west of the British Isles (Fig. 1). This distribution of pressure resulted in a northerly airflow down the North Sea and over the sea area of interest, which is indicated in Fig. 1. During the first week the anticyclone moved east across the UK as a declining ridge followed by a **trough** of low pressure; a situation which maintained the cloud cover over the southern North Sea. On the 27 June the whole area was clear during the early forenoon but a small depression to the west of Ireland (Fig. 2) moving quickly ENE, brought an extensive sheet of cloud across southern England and into the North Sea by afternoon. However, a successful flight was achieved before the arrival of the cloud.

The small wave depression continued to move east and although there were large amounts of cloud over England and the Continent on the 29th, a clear area over East Anglia was forecast to move over the southern North Sea, which it duly did and permitted another flight to be accomplished (Fig. 3).

On 3rd July pressure was high over Biscay and the Continent (Fig. 4). The area from the Azores to the Zuider Zee was clear of cloud and, apart from some early patches of coastal fog which soon cleared in the forenoon, there were no problems. This last day of the trial was the best of the period - at least meteorologically speaking - and a very good run was achieved.

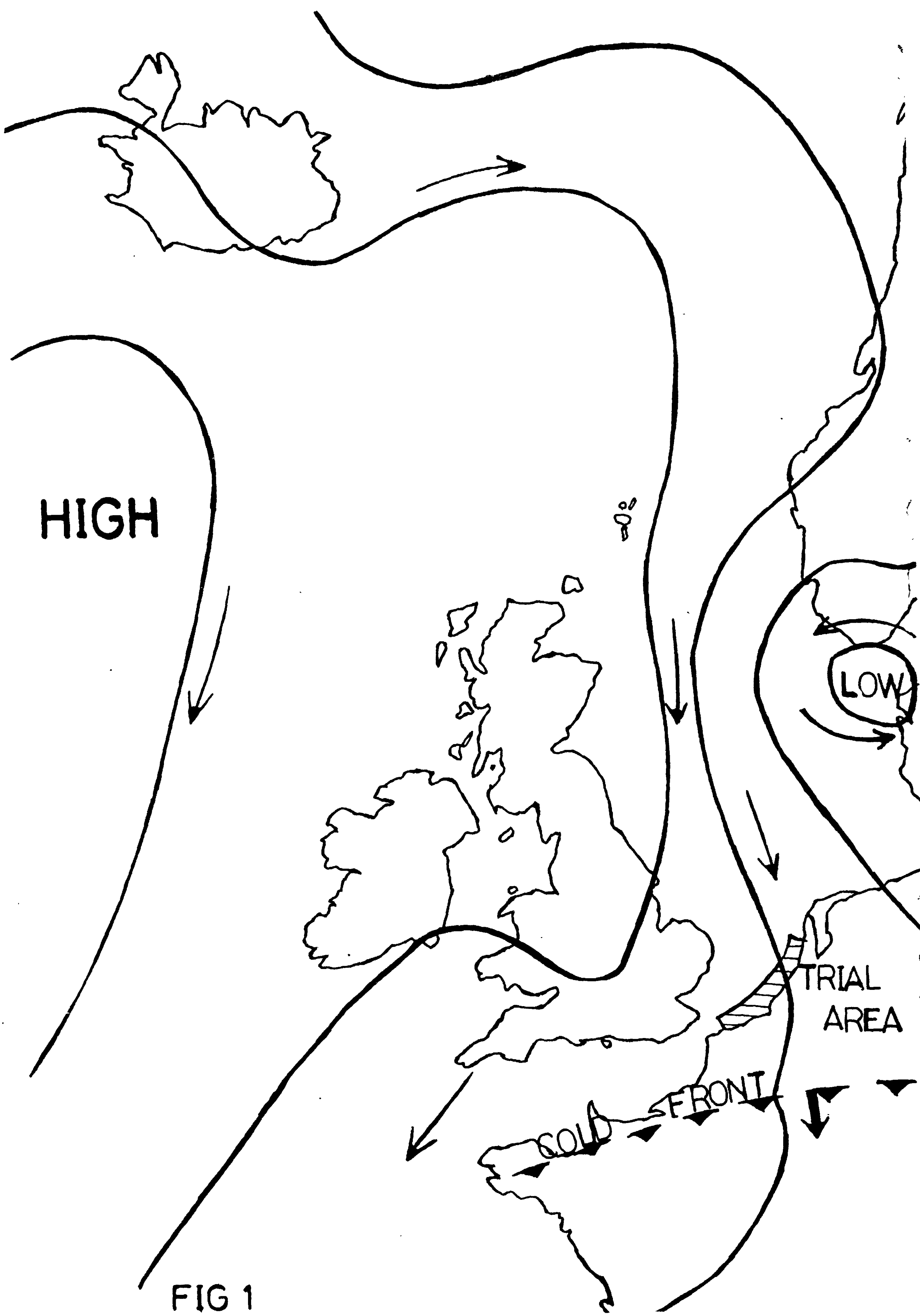


FIG 1

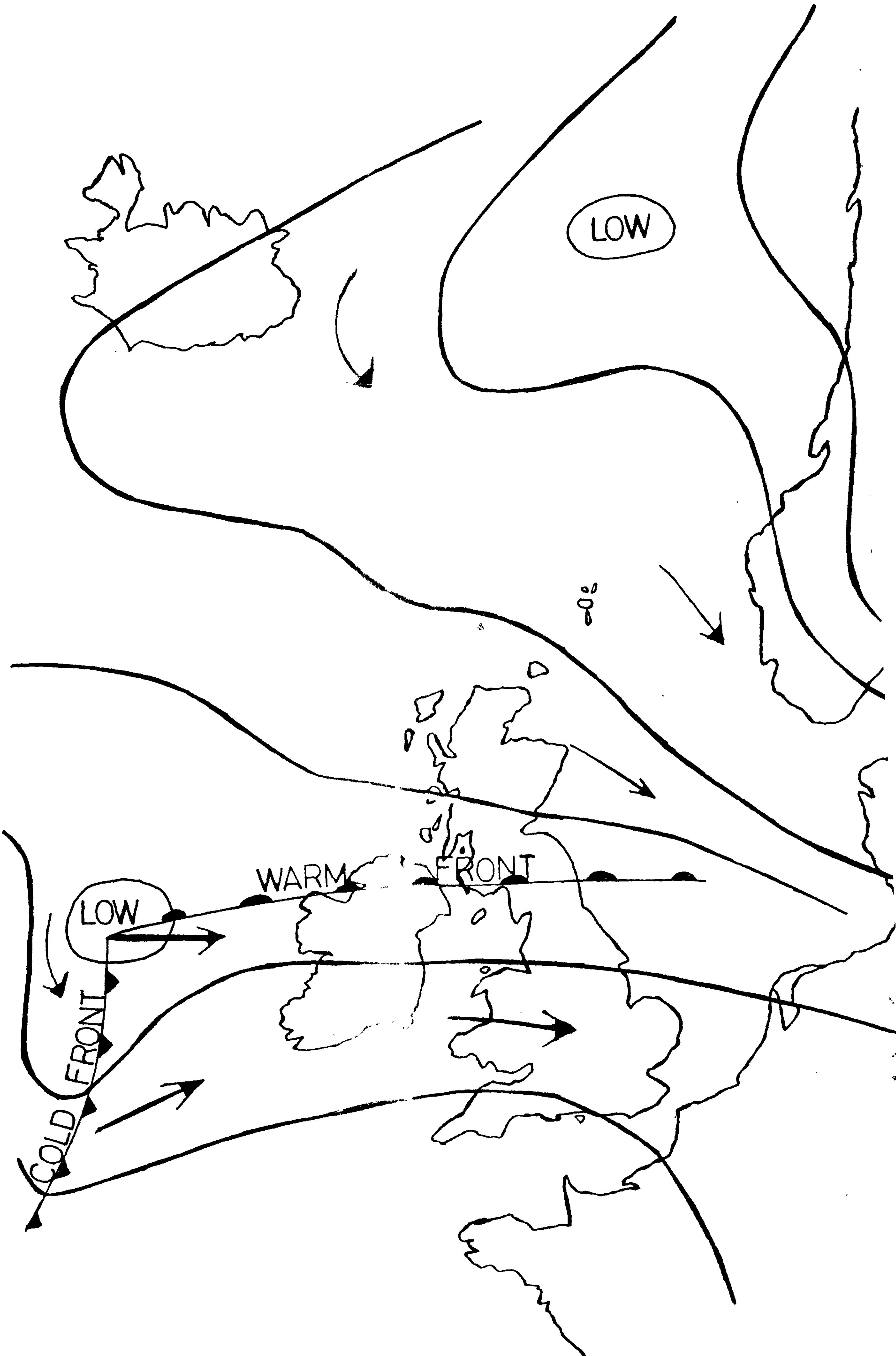


FIG 2

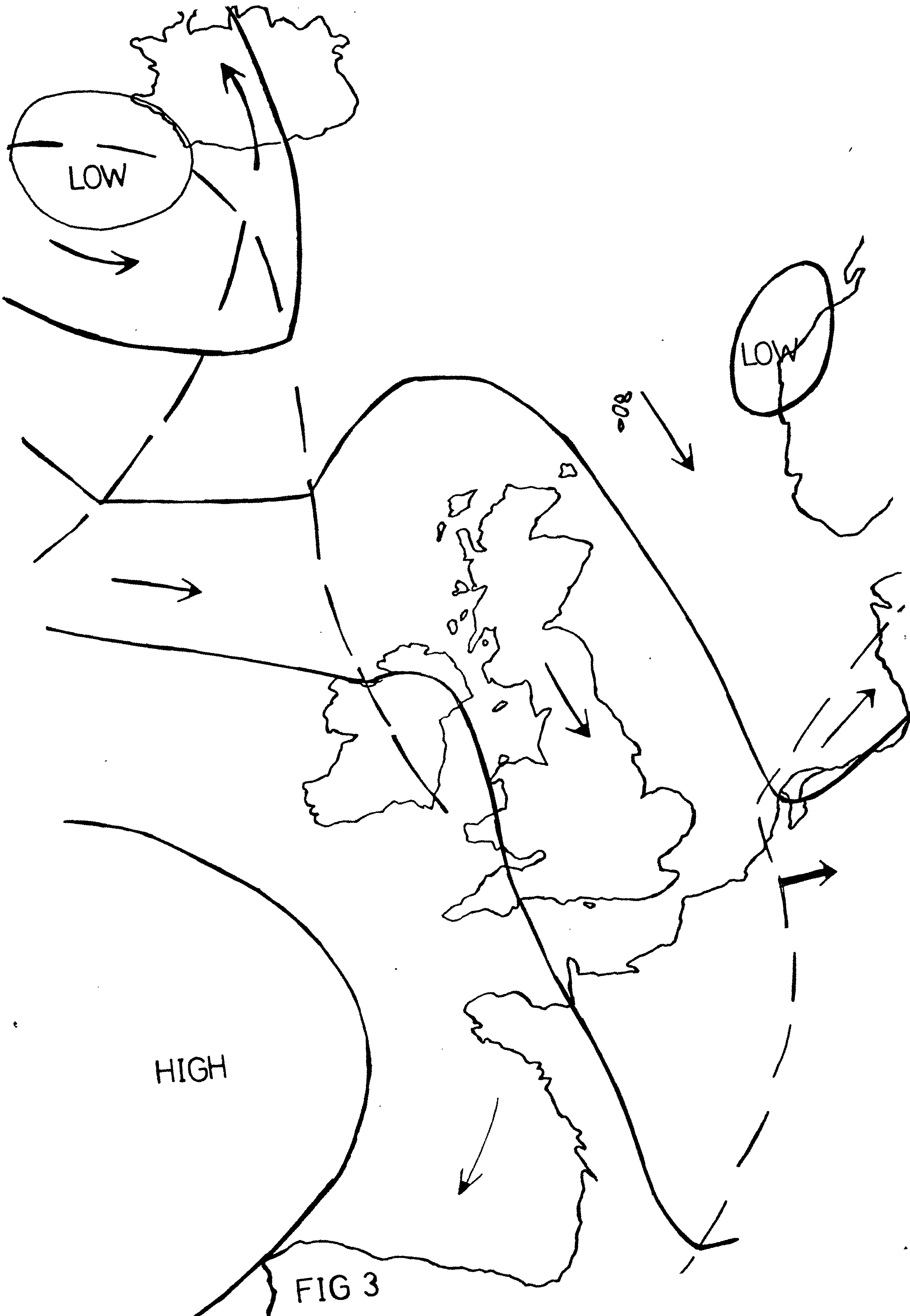


FIG 3

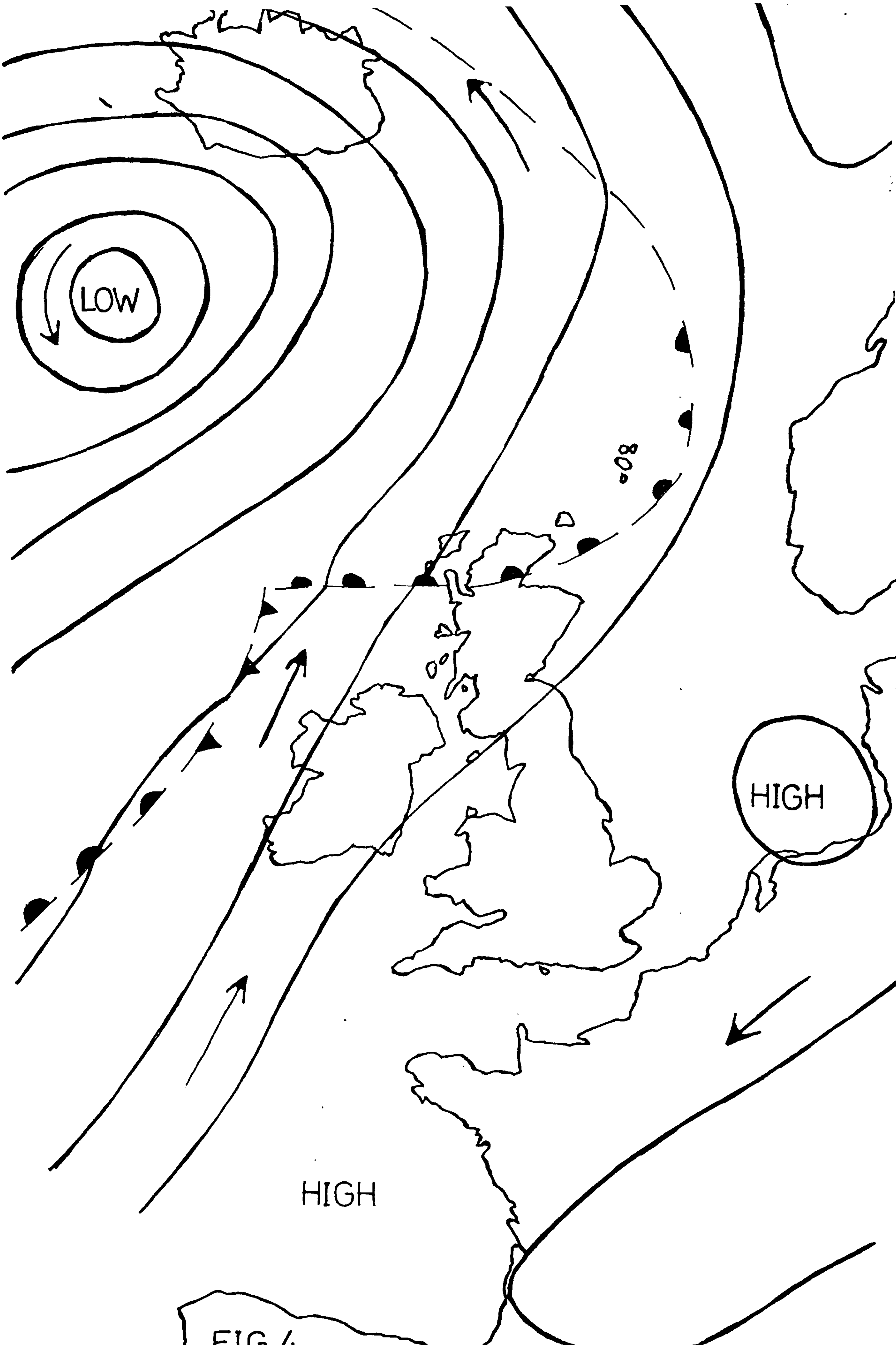


FIG 4